

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

Case: IPR2025-00432

U.S. Patent No. 11,575,148

**SUPPLEMENTAL DECLARATION OF DEAN R. WHEELER, Ph.D., IN
SUPPORT OF PATENT OWNER'S RESPONSE**

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I, Dean R. Wheeler, Ph.D., do hereby declare and say as follows:

I. INTRODUCTION

1. I have personal knowledge of the facts contained in this Declaration, am of legal age, and am otherwise competent to testify.

2. I have been retained by Ningde Amperex Technology Ltd. (“ATL” or “Patent Owner”) as an independent technical expert in this proceeding before the United States Patent and Trademark Office (“PTO”) Patent Trial and Appeal Board (“PTAB”) regarding U.S. Patent No. 11,575,148 (the “’148 Patent”).

3. I understand that Zhuhai CosMX Battery Co., Ltd. (“Petitioner”) filed a petition for *Inter Partes* Review (“IPR”) of the ’148 Patent (“Petition”), in which Petitioner asserts that:

- Claims 1, 2, 5-11, and 14-19 are obvious over U.S. Patent Application Publication No. 2017/0162849 A1 (“Murakami”) (Ground 1);
- Claims 3 and 12 are obvious over Murakami and International Patent Application Publication No. WO 2015/178351 (“Honda”) (Ground 2);
- Claims 4 and 13 are obvious over Murakami and Japan Patent Application No. 2017-137432 (“Tanaka”) (Ground 3);
- Claims 1, 2, 5-11, and 14-19 are obvious over Murakami and U.S. Patent Application No. 2012/0228214 A1 (“Beard”) (Ground 4);

- Claims 3 and 12 are obvious over Murakami, Honda, and Beard (Ground 5);
- Claims 4 and 13 are obvious over Murakami, Tanaka, and Beard (Ground 6);
- Claims 1-3, 5-12, and 14-19 are obvious over Beard and U.S. Patent Application Publication No. 2016/0013465 (“Akiike”) (Ground 7);
- Claims 4 and 13 are obvious over Beard, Akiike, and Tanaka (Ground 8).

4. I previously submitted a Declaration in this proceeding in support of Patent Owner’s Preliminary Response to the Petition (Ex. 2015).

5. I understand that the Board issued a decision granting institution based on the Petition on August 26, 2025.

6. I have been asked to submit this Supplemental Declaration to analyze and respond to assertions in the Petition and Institution Decision and the evidence cited therein.

7. As explained below, the Petition fails to show that Claims 1-19 of the ’148 Patent are rendered obvious.

8. I am being compensated for my time spent on the present matter at my customary consulting rate of \$350 per hour for preparatory work and at my customary consulting rate of \$450 per hour for depositions/trial work. I am also

being compensated for expenses incurred as a result of activities performed as an expert. My compensation is in no way contingent on the nature of my opinions, the outcome of this or any other proceeding, or any of the issues involved therein. I have no other interest in this proceeding.

II. BASIS FOR OPINIONS

A. Qualifications

9. My qualifications and professional experience are described in my *curriculum vitae*, a copy of which was provided with my preliminary Declaration (Ex. 2015) as Ex. 2016. I also provided a brief summary of my qualifications and professional experience in Paragraphs 7-13 of that Declaration (Ex. 2015), and I incorporate those paragraphs by reference herein.

B. Materials Considered

10. The opinions contained in this Declaration are based on the documents I reviewed, as well as my education, years of professional experience, and knowledge. In forming my opinions expressed in this Declaration, I further reviewed the Petition, all exhibits or other material cited therein, the Board's Institution Decision, and any additional exhibits or other material cited in my preliminary Declaration (Ex. 2015) and this Declaration.

11. This Declaration presents the opinions I have formed at the present time, and I reserve the right to revise, supplement, or amend my opinions stated in this Declaration based on any new information that I may be asked to review.

12. As I discuss below, I disagree with Dr. Gido's conclusions that the subject matter of any of Claims 1-19 of the '148 patent would have been obvious.

III. LEGAL STANDARDS

13. I provided a summary of my understanding of certain legal standards in Paragraphs 17-40 of my preliminary Declaration (Ex. 2015), and I incorporate those paragraphs by reference herein. In this section, I describe my understanding of certain legal standards. I have been informed of these legal standards by Patent Owner's legal counsel. I am not an attorney, and I am relying only on instructions from Patent Owner's legal counsel for these legal standards.

IV. TECHNOLOGY OVERVIEW

14. I provided a brief technical overview in Paragraphs 41-48 of my Preliminary Declaration (Ex. 2015), and I incorporate those paragraphs by reference herein. I also provide supplemental technical information below to elaborate on certain concepts discussed in my previous declaration.

A. Lithium-Ion Battery Separators

15. One of the critical components of lithium-ion batteries is the separator. The separator serves the key function of preventing contact between electrodes. Ex.

2028 at 99. At the same time, separators must allow for high ionic conductivity. *Id.* Ionic conductivity is when electrons flow from one electrode to the other by passing through channels, or pores, in the separator. *Id.* Pore structure is therefore key to how a separator operates. In addition, a separator must also be designed to not react to the electrolyte solution in a way that negatively affects ionic conductivity or other requirements of successful battery operation. *Id.* For example, it is important that the pores in the separator do not become blocked because of reactions with the electrolyte solution. *Id.*

16. As I explained in my Preliminary Declaration, “[t]he various design considerations for separators require an extremely delicate balance of elements in the composition of the separator and its components,” and “[e]xperts in the field have been working on that balance for decades.” Ex. 2015 ¶ 45. Additional information regarding this balance of elements is provided herein. As one example, when creating a separator, it is necessary to consider factors such as chemical and electrochemical stability, wettability, thickness, porosity, pore size, permeability, air permeability, mechanical properties, puncture strength, dimensional stability, thermal shrinkage, shutdown, and high-temperature stability. *See, e.g.*, Ex. 2035 (Deimede) at 3-5.

17. There are many different separator designs, each with its own pore structure, and which type of separator is used can vary widely based on different

objectives, such as operating temperature and mechanical strength requirements, and other factors, such as cost. Ex. 2033 (Gido Dep. Tr.) at 88:9-92:22, 97:4-98:10, 101:19-103:7, 213:16-214:9, 245:17-246:5, 252:1-4, 268:13-16. As I explained in my Preliminary Declaration, “[o]ne workable design for a separator involves using a porous substrate, on its own, as the separator, and “the most common material is a polyolefin such as polypropylene or polyethylene.” Ex. 2015 ¶ 46 (citing Ex. 2028 at 99).

18. Examples of the structure of commercially available polyolefin separators are shown in the below scanning electron microscope (SEM) images. As depicted below, the pores in such separators may be created by stretching a sheet of polyolefin, either through a dry process or a wet process.

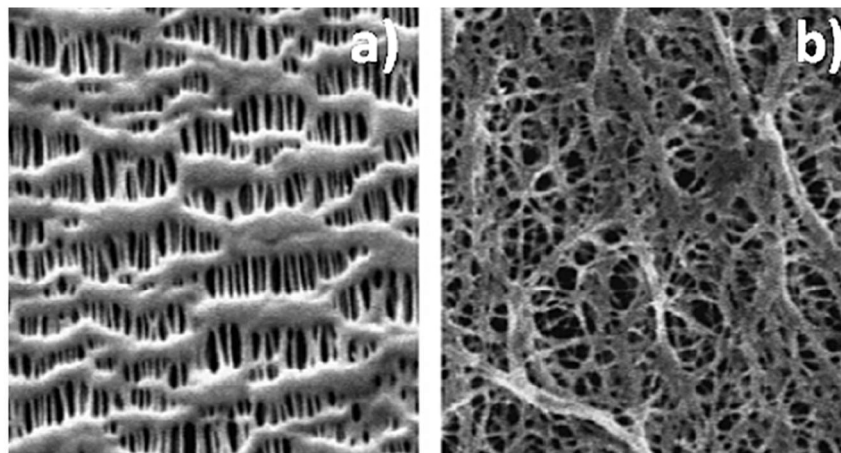


Figure 2. SEM images of the microporous polyolefin membranes made by using a a) dry process and b) wet process, respectively. Reprinted with permission from Ref. [2], Copyright 2004, American Chemical Society.

Ex. 2035 at Fig. 2; *see also* Ex. 2031 ¶¶ 41-42 (Dr. Guido testifying in another IPR declaration as to these types of separators, noting that both a dry and wet process often incorporate stretching and that stretching “opens up voids or pores in the film”).

19. While these types of microporous polyolefin separators are good commercial candidates because they are relatively easy to mass produce and exhibit favorable shutdown and ion exchange characteristics, they also have certain limitations. Ex. 2035 at 10; Ex. 2031 ¶¶ 44-46. For example, polyolefin materials tend not to be as heat-resistant as other materials, meaning that these types of separators are not effective candidates for batteries that require higher temperature stability. *Id.*

20. As I explained in my Preliminary Declaration, “[a]nother technique is to use a separator that is made up of a porous substrate with an additional and attached porous layer, either on one side or both sides.” Ex. 2015 ¶ 47 (citing Ex. 1005 ¶¶ [0004]-[0005]). As explained previously, “[t]his porous layer may be made up of many types of materials, including different types of resins, organic particles, and/or inorganic particles.” *Id.* (citing 1005 ¶¶ [0004]-[0005], [0060]).

21. One example of a possible structure for these types of separators (i.e. separators that add a porous layer to a polyolefin base) is provided below.

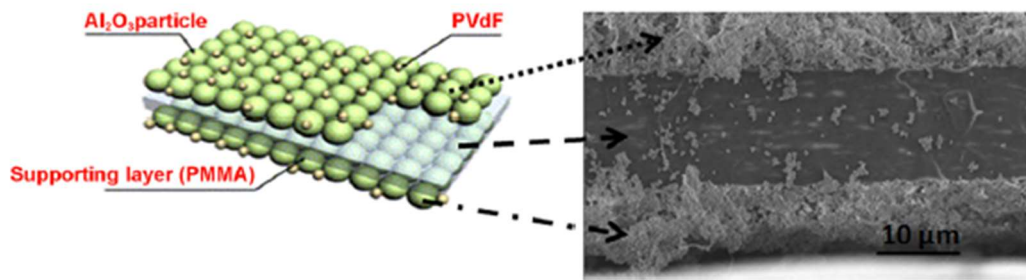


Figure 7. Schematic diagram as well as SEM image of an organic/inorganic trilayer separator. Reprinted with permission from Ref. [114], Copyright 2010, Elsevier.

Ex. 2035 at Fig. 7.

22. In this example, two porous layers were added to the supporting porous base, one on each side. As illustrated above, the pores in the porous layer are formed by gaps between the inorganic particles (Al_2O_3 , or alumina, particles). There is also a relatively small amount of binder (PVdF-HFP, in a mass ratio of 10:90 with the alumina), which in this example is globular and serves to adhere the Al_2O_3 particles to the supporting base layer (PMMA). The porous layer here is an example of what Dr. Guido has called a “high particle loading” porous layer, in that it contains “up to as much as 90% by weight, or more” filler (in this example, 90% by weight alumina particles). Ex. 2031 ¶ 52.

23. Another example of a different possible structure for the porous layer in these types of separators is provided below.

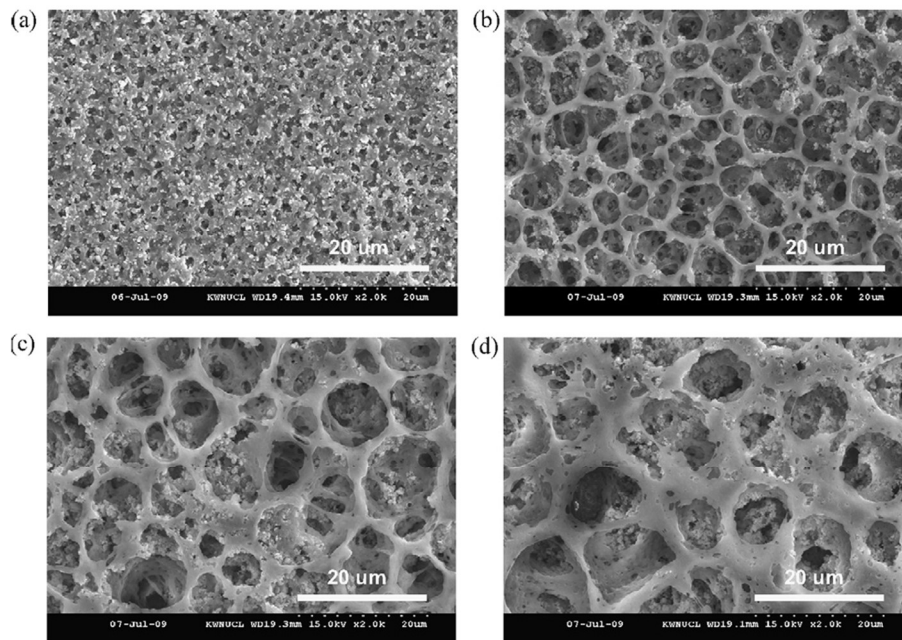


Fig. 3. FE-SEM photographs for $\text{Al}_2\text{O}_3/\text{PVdF-HFP}$ (=50/50, w/w) ceramic coating layers as a function of water content in coating solutions: (a) 1.89 wt%; (b) 3.77 wt%; (c) 5.66 wt% and (d) 7.55 wt%.

Ex. 2036 at Fig. 3.

24. The porous layer here is an example of a layer similar to what Dr. Gido has referred to as one “in which the amount of polymer binder in the ceramic particle containing layer is significantly greater, perhaps more than 50%.” Ex. 2031 ¶ 52. In this example, the relative amount of binder is 50% by weight. Ex. 2036 at Fig. 3 (explaining that the $\text{Al}_2\text{O}_3/\text{Pvdf-HFP}$ ratio is “50/50, w/w”). As shown above, the pores here are not formed by gaps between inorganic particles but rather are delineated by the binder. As Dr. Gido predicted for this type of structure, the small inorganic particles in this example are “separated from one another and surrounded by binder.” Ex. 2031 ¶ 52.

25. Given that there is so much more binder (and fewer particles) in this type of porous layer, a POSITA would have understood that “it is necessary to generate porosity in the binder polymer itself,” which is “typically done by a solvent/non-solvent coagulation, known as a phase inversion processing method.” *Id.* The result of a phase inversion process method can vary significantly depending on variables such as the ratio of solvent to non-solvent. This can be seen in the pore structure above (Figure 3 of Ex. 2036), which shows variations in pore size and pore wall thickness as a function of changing the weight percent of water in the non-solvent that is added to the binder/solvent solution to make the binder coagulate out of solution.

26. These are not the only two types of pore structures for these types of porous layers. There are many other possible variations, and the pore structure of a particular porous layer may vary widely depending on a wide range of factors, including for example: the types of materials used, the amounts of the materials, the size of the materials, how the materials are mixed and handled, and how the materials are applied to the polyolefin layer. Ex. 2037; *see also* Ex. 2033 (Gido Dep. Tr.) at 83:6-84:6, 94:22-97:3, 211:10-212:18. Even a small change in one of the variables used in forming a porous layer can have a significant impact on the resulting structure of the porous layer, including for example: the shape of the pores, the size of the pores, the wall thickness between pores, the composition of the cell wall

between pores (i.e. what materials make up the pore walls), the spatial extent of the pores (e.g. whether there are pores that span the entire thickness of the porous layer), whether any materials extend into the pores, and how “tortuous” the pore pathways are (i.e. the degree of crookedness).

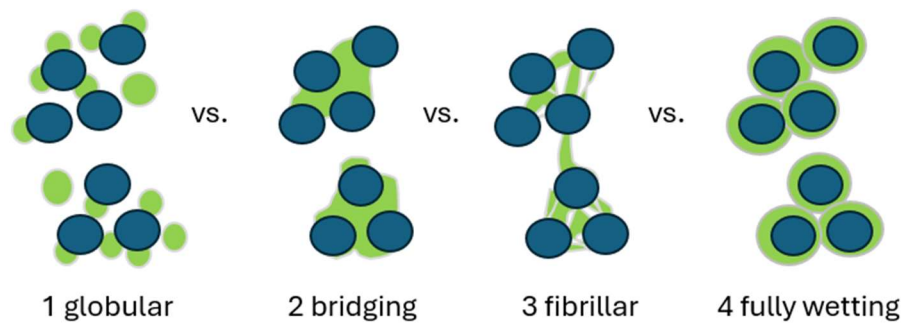
27. I have provided a few examples and corresponding graphic illustrations below (not to scale) to illustrate this point. It is important to note that these variables do not always function independently. Ex. 2033 (Gido Dep. Tr.) at 96:3-97:3. Rather, they have a complex interrelationship with each other (and with many other variables that are involved in manufacturing separators). Ex. 2033 (Gido Dep. Tr.) at 204:22-205:9 (Dr. Gido explaining that for various factors affecting pore structure and pore creation discussed below, “it’s not a simple 1:1 relationship”). Thus, it is often difficult to predict how changing one or two variables will alter the pore structure of the final porous layer without experimentation. *See, e.g.*, Ex. 2033 (Gido Dep. Tr.) 205:10-206:15 (“You know, if you did everything all the same and all you changed was the particle size, I don’t know what in these various examples might happen.”). While there are some generally accepted truths (e.g. the more binder, the more the adhesive effect of the porous layer, at the expense of lower porosity and lesser ion flow), the exact resulting pore structure can be unpredictable and requires extensive experimentation and testing to determine. *See, e.g., id.* (“So, you know, you can move this parameter space all over the place and get different pore sizes and

different porosities for all kinds of different reasons.”); *id.* at 259:19-260:9 (“But you know, a POSITA would need to, you know, do some tests, make some sample materials and investigate them to see how that works out, right.”).

28. One variable that has a critical impact on pore structure in a porous layer containing both binder and inorganic particles is the amount of binder relative to the amount of inorganic particles. *See, e.g.*, Ex. 2031 ¶ 52 (Dr. Guido testifying in a different IPR declaration contrasting the pore structure of separators that “use high particle loadings up to as much as 90% by weight, or more” versus pore separators “in which the amount of polymer binder in the ceramic particle containing layer is significantly greater, perhaps more than 50%.”); *see also, e.g.*, Ex. 2054 at Fig. 1 (illustrating that high powder vs. low powder results in substantially different pore structures). As shown in the illustration below, the amount of binder relative to inorganic particles influences whether the inorganic particles are enveloped by the binder (left), or whether the binder only acts like little dots of glue to hold the particles together (right).



29. Another variable that significantly impacts pore structure in this type of porous layer is the type of binder used and, for example, whether that binder tends toward *cohesion* (sticking to itself) versus *adhesion* (sticking to other materials). In the illustration below, the ratio of adhesive force to cohesive force is increasing from left to right (although other variables, such as the amount of binder (described above) and the method of solidification (described below) will also have an effect). In case 1 (far left), the binder is cohering to itself strongly and therefore forming globules and minimizing its contact area with the particles. In case 2 (middle left) the binder has greater adhesion and is forming gap-filling bridges between particles. In case 3 (middle right), the binder is forming strings or fibers that strongly adhere to particles and less so to itself and does not minimize surface area. In case 4 (far right), the binder adheres to the particles so much that it completely coats or wets them. As Dr. Guido explained in his deposition, wetting is “a thermodynamic driving force to coat or spread on the surface” of a particle that is influenced by chemical interactions between the binder and filler particle. Ex. 2033 (Guido Dep. Tr.) at 221:6-19. There are certain polymers that can be used as a binder that, depending on the particles used, will cause the binder to “extend over or creep over the surface of the particle” (i.e. “wetting” or “coating” the particle). *Id.*, at 221:20-222:8.



30. Another variable that significantly impacts pore structure in this type of porous layer is the method of solidification (drying method, solvent substitution, NIPS (non-solvent-induced phase separation), etc.). Ex. 2033 (Gido Dep. Tr.) at 211:10-213:5. For example, the method of simply drying a coating solution to create a porous layer does not involve a coagulation process. All that happens is that the solvent is removed (e.g. evaporated off), the particles and binder that were in the solvent stay attached to each other and the porous substrate (because of the binder), and the result is a dry porous layer formed like a sheet on top of the porous substrate. In contrast, NIPS involves a coagulation step wherein the solvent is replaced by a non-solvent (something that the binder cannot dissolve in), thereby forming pores by coagulating the binder out of the solution. As described below, NIPS is one species in the broader genus of phase separation methods and is the process the '148 Patent uses to form its porous layer. *See, e.g.*, Ex. 1001 at 5:61-7:42; Ex. 2015 ¶¶ 56-58. The specific requirements of NIPS versus other types of phase separation methods are explained in more detail in Paragraphs 56-58 and 93-96 of my Preliminary Declaration. However, as explained above in Paragraph 23 and

illustrated in Fig. 3 of Ex. 2036, a POSITA would have understood that variables such as the types of solvents and non-solvents used, their amounts, and the amount of binder have a significant impact of the resulting pore structure. *See also, e.g.,* Ex. 2033 at 114:16-115:21 (Dr. Gido explaining that the way a coagulation process works “depends on the quality of the solvent” and “depends on the amount of polymer”). In Fig. 3, for example, the variable that was changed between (a), (b), (c), and (d) is the amount of water that was in the non-solvent. As you can see below, even small changes in weight % of water (less than 2 weight % increases) had a significant impact on pore structure, including for example pore size and pore wall thickness.

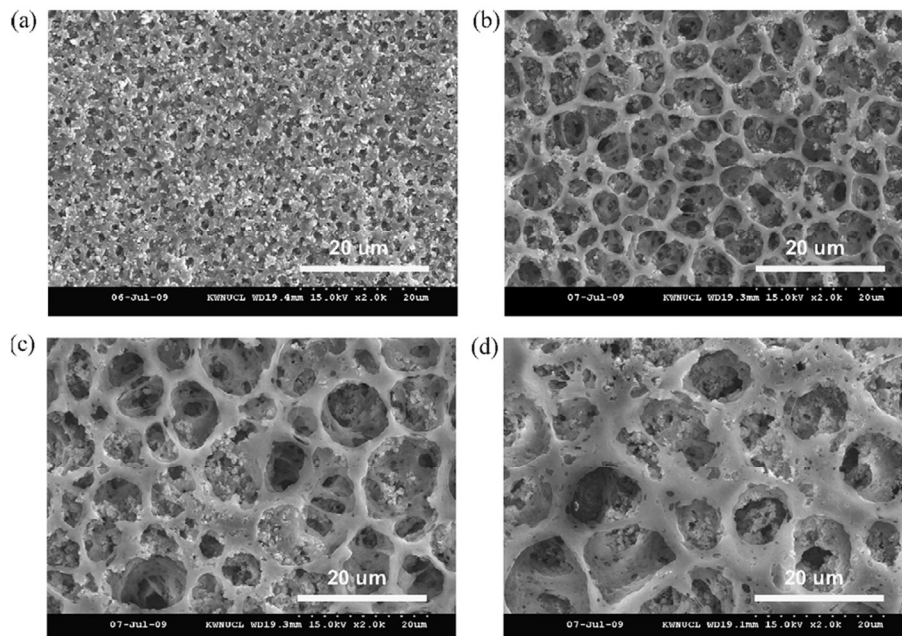
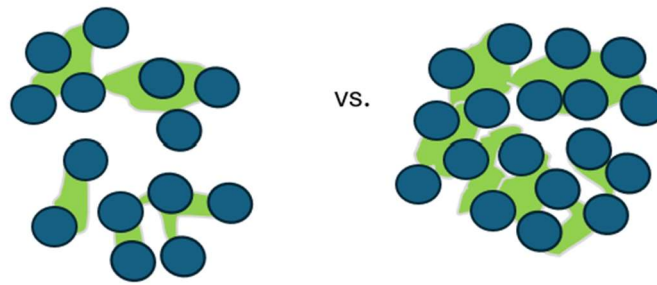


Fig. 3. FE-SEM photographs for $\text{Al}_2\text{O}_3/\text{PVdF-HFP}$ (=50/50, w/w) ceramic coating layers as a function of water content in coating solutions: (a) 1.89 wt%; (b) 3.77 wt%; (c) 5.66 wt% and (d) 7.55 wt%.

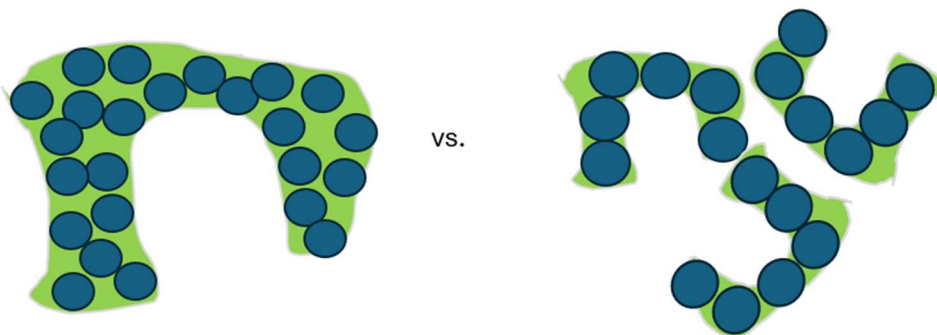
31. Other variables that significantly impact pore structure in this type of porous layer are particle size and particle size distribution. Ex. 2033 (Gido Dep. Tr.) at 204:22-207:1. As shown in the illustration below, smaller particle sizes tend to have stronger interactions with the binder due to greater surface area for a given mass. Additionally, smaller particles can efficiently fill in spaces between larger particles, leading to an altered pore structure. This is illustrated below, where a uniform particle size distribution will invariably exhibit a different, likely more consistent, pore structure (right) than a case where the particle sizes cover a broad spectrum (left).



32. Another variable that influences pore structure in this type of porous layer is porosity (i.e. the volume fraction of the pores). *See generally* Ex. 2033 (Gido Dep. Tr.) at 94:22-97:3 (Dr. Gido agreeing that many factors, including porosity, are important separator design considerations); *id.* at 213:6-15. As shown in the illustration below, some porous layers have a greater percentage of empty space, or voidage, which is represented as a higher porosity value (left). Other porous layers favor less voidage, which is represented as a lower porosity value (right).



33. Another variable that influences pore structure in this type of porous layer is the width of pore walls relative to the size of the particles. *See generally* Ex. 2033 (Gido Dep. Tr.) at 94:22-97:3 (Dr. Gido agreeing that many factors, including width of pore walls, are important separator design considerations); *id.* at 213:6-15. As shown in the illustration below, a porous layer with pore walls made of binder might have thick enough walls to encompass multiple layers of inorganic particles (left) or it might have thinner walls that only encompass a single layer of inorganic particles (right).

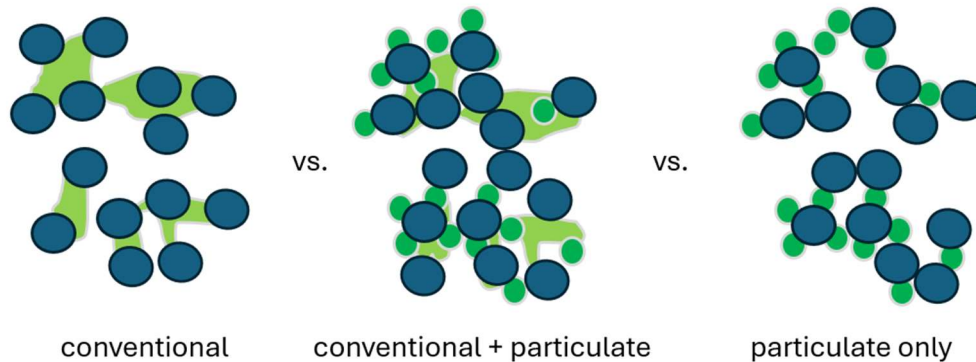


34. Another variable influencing pore structure in this type of porous layer is whether the inorganic particles protrude into the pores, and if so, to what extent. Ex. 2033 (Gido Dep. Tr.) at 93:1-94:6 (Dr. Gido admitting that a POSITA would

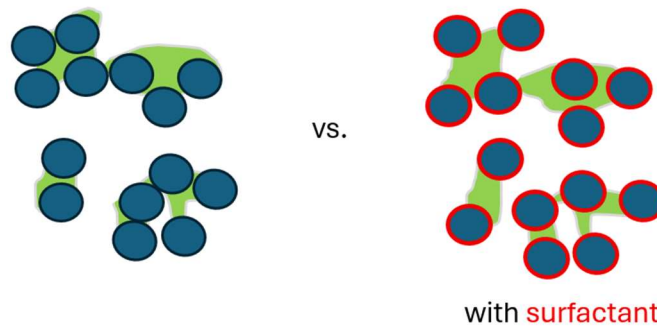
want to minimize the extent particles extend or protrude into the pore itself to minimize the risk of the particles falling off the porous layer). As shown in the illustration below, it is possible to have porous layers where the inorganic particles remain in the pore walls and do not extend into the pores (left), while other porous layers have inorganic particles as part of the pores themselves (right).



35. Another variable influencing pore structure in this type of porous layer is whether one uses more than one type of binder. *See generally* Ex. 2033 (Gido Dep. Tr.) at 94:22-97:3 (Dr. Gido agreeing that many factors, including type of binder used, are important separator design considerations). For example, a traditional binder is one that is dissolved in solvent such that, once the solvent is removed, the binder coagulates (i.e. re-solidifies) into fibers or blobs or other configurations, depending on the circumstances. A particulate binder is one that does not dissolve in the solvent but rather retains a particulate shape. Many porous layers only include a traditional binder (left), while others may include a particulate binder as well (middle). There are still other porous layers which may use a particulate binder *instead of* a traditional binder (right).



36. Another variable influencing pore structure in this type of porous layer is whether there are other components in the porous layer besides binder and inorganic particles. *See, e.g.,* Ex. 2033 (Gido Dep. Tr.) at 258:2-260:9 (Dr. Gido explaining some of the effects of additionally including a surfactant). For example, some porous layers might also include a surfactant, which is a component that acts as an interface between two other components that have different properties. Ex. 2033 (Gido Dep. Tr.) at 257:1-258:1. For example, soap is a surfactant that works by letting oil (usually not miscible with water) distribute into smaller blobs that are spread out in the water. *Id.* In the case of a composite with binder and inorganic filler particles, the surfactant will modify surface-energy interactions for binder to filler, binder to void, filler to filler, and/or filler to void. An example of how a surfactant could modify the porous layer by weakening attractions between inorganic particles is shown below. Other modifications are possible depending on the nature of the particles, binder, solvent, and surfactant.



37. Each of these various structural characteristics are important because together they determine the behavior and properties of the porous layer. Ex. 2038 (Lagadec et al.) at 3-5, 8; *see also* Ex. 2033 (Gido Dep. Tr.) at 96:3-97:3. For example, pore size affects properties like the mechanical strength of the separator (greater pore size typically leading to lower mechanical strength) and the rate of ion transfer between electrodes (greater pore size typically leading to a higher rate). Ex. 2033 (Gido Dep. Tr.) at 101:19-103:1; *see also* Ex. 2036 (Jeong). The relative amount of binder compared to inorganic particles affects properties like the heat-resistant properties of the separator (a higher percentage of inorganic particles typically leading to greater heat resistance) and the adhesion of the layer to other components of the separator or electrodes (a higher percentage of binder typically leading to greater adhesion). Ex. 2039 (Kim). And whether the inorganic particles extend into the pores (and to what degree) affects the pore size and therefore affects properties like the mechanical strength of the film and the rate of ion transfer between electrodes. Ex. 2033 (Gido Dep. Tr.) at 93:1-94:6 (Dr. Gido agreeing that a

POSITA would want to minimize the risk of the particles falling off the porous layer, which is more likely when the particles are extending into the pore itself instead of fully encapsulated in binder).

38. Moreover, the desired structure of the porous layer is different based on different objectives. Ex. 2033 (Gido Dep. Tr.) at 88:9-92:22, 97:4-98:10, 101:19-103:7, 213:16-214:9, 245:17-246:5, 252:1-4, 268:13-16. For example, a POSITA wanting to create a porous layer with the best possible heat-resistant characteristics would want to maximize the ratio of inorganic particles to other components in the porous layer, such as binder. As another example, a POSITA wanting to create a porous layer with consistent porosity throughout (e.g. one where the pores are as similar as possible in size and shape for the entire thickness of the porous layer) would want to avoid steps during manufacture that increase variability in the pores, such as having inorganic particles extend into the pores or not having a narrow enough particle size distribution. *See, e.g.*, Ex. 2033 at 204:3-205:9 (Gido Dep. Tr.) (Dr. Gido explaining how particle size and particle size distribution can affect pore size and geometry).

39. In sum, creating a porous layer for a separator is not a trivial task, and doing so requires extensive experimentation to achieve the desired balance of properties.

B. The '148 Patent

40. I provided an overview of the '148 Patent in Paragraphs 49-66 of my Preliminary Declaration (Ex. 2015), and I incorporate that discussion by reference herein.

V. LEVEL OF ORDINARY SKILL IN THE ART

41. I incorporate Paragraphs 67-69 of my Preliminary Declaration (Ex. 2015) by reference herein.

VI. CLAIM CONSTRUCTION

42. I understand that neither the Petition nor Dr. Guido set forth any express constructions for any claim terms, nor is there any argument in this proceeding that any claim terms are indefinite. However, I understand that in a separate district court action involving the '148 Patent, Petitioner contended for the first time on September 30, 2025 that the term “the pores at least comprises a part of the inorganic particles” is indefinite. Ex. 2032 (District Court Claim Construction Filing). Not only is this argument inconsistent with the claim construction positions set forth in the Petition and Dr. Guido’s Declaration, and neither have set forth a basis for proceeding on a “plain and ordinary” construction and applying this construction to the prior art in this proceeding while they simultaneously contend in district court litigation that this term cannot be understood by a POSITA, but I also disagree that this term is indefinite for the reasons set forth below with respect to that term.

43. Moreover, while I agree that all the terms in the '148 Patent should be given their plain and ordinary meaning from the perspective of a POSITA in view of the patent's specification and prosecution history, Petitioner and Dr. Guido's arguments to-date in this proceeding, as well as the Board's Institution Decision (Paper No. 10), have made clear that we disagree on what that plain and ordinary meaning is for certain terms. I therefore address the plain and ordinary meaning for each disputed term below.

A. Pores “Formed by the Binder”

44. Neither the Petition nor Dr. Guido expressly discuss the plain and ordinary meaning of pores “formed by the binder.” However, both rely on the (unsupported) assumption that any type of pore or void that exists within a layer that includes binder and inorganic particles necessarily constitutes a pore “formed by the binder.” *See, e.g.*, Ex. 1003 (Guido Decl.) ¶ 90; Paper 2 (Petition) at 23. During his deposition, Dr. Guido explained his position further, arguing that all systems that have pores and binder necessarily have pores “formed by the binder” because the binder holds the particles together, and the particles delineate the pores. Ex. 2033 at 37:8-15 (opining that “there are no pores formed if the binder is not there holding the particles together. So the pores are formed by the binder. The pores are formed by the particles and the pores are formed by the binder”). The Institution Decision

appears to have adopted this broad interpretation of pores “formed by the binder.”
Paper No. 10 at 17.

45. Respectfully, I disagree that this interpretation, which Petitioner contends includes pores that are created by space or voids between particles rather than created by space or voids formed between walls of binder, reflects the plain and ordinary meaning of pores “formed by the binder.” In particular, such a construction of “pores formed by the binder” nullifies the explicit claim language, “formed by the binder,” and is contrary to the plain and ordinary meaning of the term.

46. I provided a discussion of the plain meaning of this term in Paragraphs 78-82 of my Preliminary Declaration (Ex. 2015), and I incorporate by reference that discussion herein. Given the Institution Decision’s apparent adoption of Petitioner’s construction, however, I provide additional analysis below to explain how a POSITA would have understood the plain and ordinary meaning of this term.

47. A POSITA would have understood the plain and ordinary meaning of this phrase, “formed by the binder,” to require that the pore geometry is itself defined by the boundaries of the binder, rather than by some other component of the porous layer. This is evident from the structure and language of independent claim 1.

48. The claim language requires a porous film that comprises, or includes, at least three components: (1) “a binder,” (2) “inorganic particles,” and (3) “pores.”
As I explain in detail below with respect to the limitation that “pores at least

comprise[] a part of the inorganic particles,” pores are voids or interstitial spaces—the plain and ordinary meaning of the term pore does not include the wall that defines the outer limits of the pore. *See* discussion *infra* at Paragraph 61. Regardless, however, the key issue for purposes of *this* limitation is the meaning of the phrase “formed by the binder.” The claim language does not stop at requiring just three components (1) binder, (2) inorganic particles, and (3) pores). Instead, the claim goes on to specify certain conditions for the claimed pores, namely that the pores: (a) are “formed by the binder,” and (b) “at least comprise[] a part of the inorganic particles.” The claim language then adds specifications for the inorganic particles, namely that (i) the inorganic particles must have the claimed particle size distributions (Dv10, Dv50, and Dv90), (ii) Dv90 is greater than Dv50 which is greater than Dv10, and (iii) the ratio of Dv90 to Dv10 for the inorganic particles is within the claimed range. Thus, in total, there are eight separate requirements set forth in claim 1 (1, 2, 3, 3(a), 3(b), 3(b)(i), 3(b)(ii) and 3(b)(iii)).

49. The addition of requirement (a), “formed by the binder,” indicates to a POSITA that the claim requires a specific type of pore formation, not just any existence of pores in a layer that also has binder present. The latter would read out the claim requirement that pores be “formed by the binder.” As explained above in Paragraphs 16-27, there are a wide variety of pore formations when it comes to porous layers. For example, some porous layers are comprised of pores that are

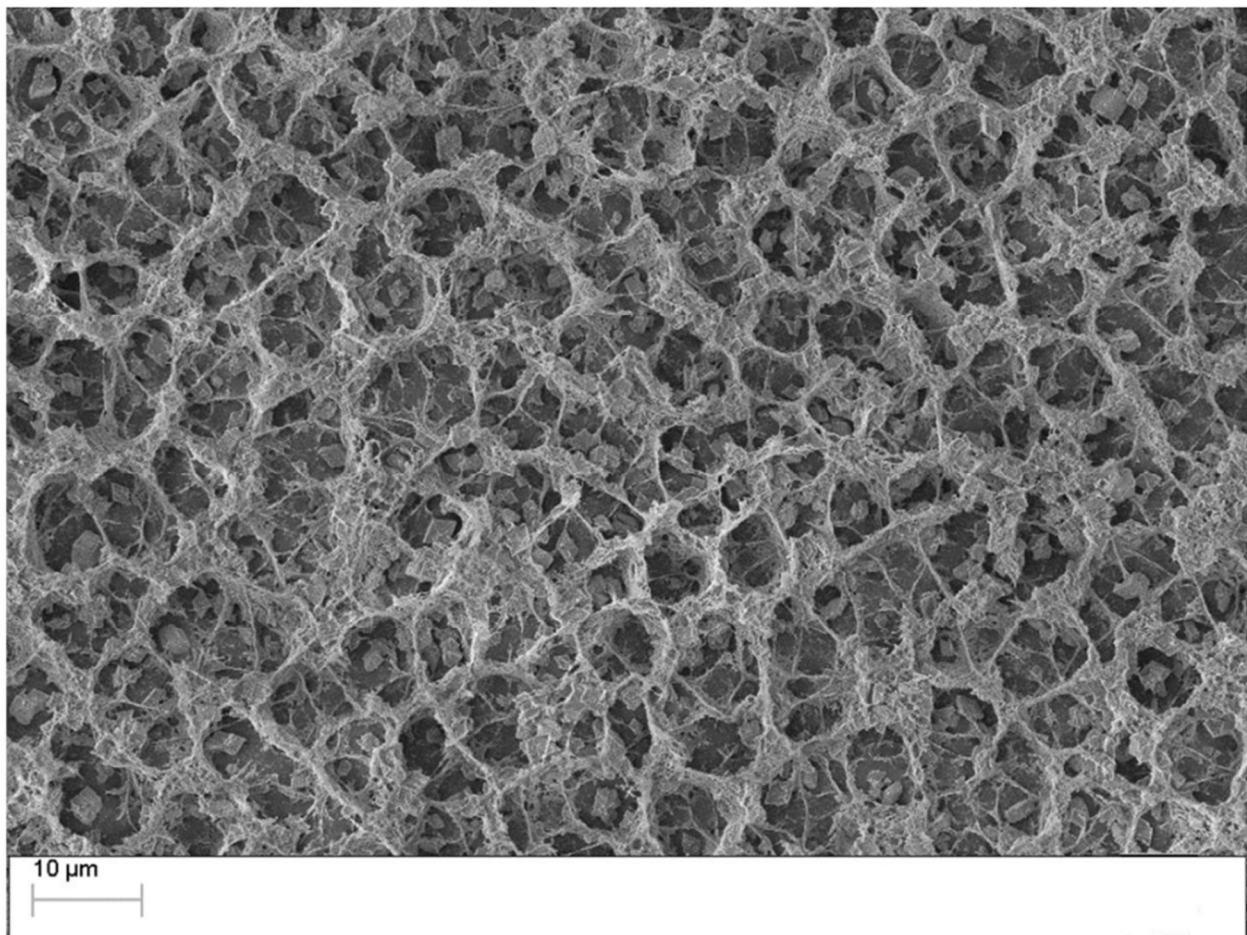
formed by gaps between inorganic particles, and those pores are not “formed by the binder” even if binder is present in the layer. *See* discussion *supra* at Paragraph 22.

50. The inclusion of claim requirement (a), that the pores be “formed by the binder,” clearly indicates to a POSITA that the claim is talking about a type of pore formation where the boundaries of the pore are delineated by the binder, like in Figures 1 and 2 of the ’148 Patent. It excludes other formations, such as a type of pore formation where the boundaries of the pore are solely delineated by gaps between inorganic particles, like in Figure 7 of Ex. 2036 or as shown in Paragraph 91, below.

51. This meaning is supported by the specification. First, as I explained in my Preliminary Declaration, “the ’148 Patent confirms this meaning by providing SEM images of its porous film that show the pores are formed by the binder.” Ex. 2015 ¶ 81. Because pore formation in porous layers is so variable and unpredictable (see Paragraphs 26-39 above), POSITAs rely on images of the resulting porous layer when closely analyzing its pore structure. Ex. 2033 (Gido Dep. Tr.) at 98:11-99:10. A common technique for imaging a porous layer as of the date of the ’148 Patent was Scanning Electron Microscopy, or “SEM.” A POSITA would have looked to the SEM images of the ’148 Patent to help inform what the claim language, “pores formed by the binder,” means. *See* Ex. 2033 (Gido Dep. Tr.) at 100:12-101:9 (Dr. Gido testifying that “to the degree that we really want to look at things, and see

exactly where they are, then taking an image is helpful”); *id.* at 110:9-12 (Dr. Gido relying on the SEM images in the ’148 Patent to characterize its pore structure).

52. As I explained in my Preliminary Declaration, “[i]n the SEM image below, for example, the white material forming a matrix or network is the binder. You can see that the spaces (or voids) in between the matrix or network are the “pores” discussed by the ’148 Patent, and that the binder itself is what defines the boundary of each pore in the same way that a circle’s perimeter defines the circle—thereby forming the pores.” Ex. 2015 ¶ 81 (citing Ex. 1001 at Fig. 1).



Ex. 1001 at Fig. 1 (the above image is a high resolution image of Fig. 1 from the file history, Ex. 1002).

53. Second, the '148 Patent specification provides a written explanation as to how the pores are formed, stating that “*the binder* in the coating solution is coagulated and separated out, *thus forming* a porous film.” Ex. 1001 at 6:26-32 (emphasis added). As explained in my Preliminary Declaration, “a POSITA would have understood this to mean that the binder in the '148 Patent is dissolved in a first solvent, and upon application of the coagulation solution, the binder forms its own solid phase with interconnected threads like a spider web, forming the pores.” Ex. 2015 ¶ 79. A detailed process for forming pores in this way, including which solvents and non-solvents to use to achieve this desired outcome, is provided in columns 5-7 of the '148 Patent. Ex. 1001 at 5:61-7:42.

54. Third, the specification provides detail regarding variables that a POSITA would understand affect pore structure (like those in Paragraphs 26-39 above), further confirming to a POSITA that “pores formed by the binder” means the pore geometry is defined by the boundaries of the binder. One key variable in this respect is the volume ratio of inorganic particles to binder. As explained above, a POSITA would have understood that porous layers made using almost entirely inorganic particles and very little binder would be unable to form pores by the binder, but rather would form pores as a result of gaps between inorganic particles. *See*

discussion *supra* at Paragraph 28; *see also* Ex. 2031 ¶ 52 (Dr. Gido testifying in a different IPR proceeding that “[s]ome separators, such as those described in the patents in Appendices L-N and Exhibit 1009, use high particle loadings up to as much as 90% by weight, or more. In these ceramic coated separator layers, ***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 interstitial cavities between the relatively tightly packed particles.***”) (emphasis added); *see also* Ex. 1003 ¶ 101 (Dr. Gido opining that “[w]ith Murakami’s binder composition consisting of nearly *all* filler material by weight or by volume, . . . [t]here is simply not enough resin material to completely subsume the much greater amount of filler—***just enough*** for ‘the filler [to be] bound by the binder resin.’”) (emphasis added) (quoting Ex. ¶ [0070]). This is ***not*** the case for separators using a porous layer having significantly more binder. Ex. 2031 ¶ 52 (Dr. Gido testifying in a different IPR proceeding that for separators “in which the amount of polymer binder in the ceramic particle containing layer is significantly greater, perhaps more than 50%” then “the particles are generally separated from one another and surrounded by binder” and “it is necessary to generate porosity in the binder polymer itself”); *see also* Ex. 2033 at 211:10-212:10 (distinguishing porous layers with “a significant amount of binder, you know, 30 percent binder or more for instance” from porous layers with much less binder). As I explained in my Preliminary Declaration, the ’148 Patent provides

for a significant amount of binder relative to the number of inorganic particles, disclosing “anywhere from 25 vol% to 83 vol% binder in the solid portion of the porous layer comprised of binder and inorganic particles.”¹ Ex. 2015 ¶ 80 (citing Ex. 1001 at 5:50-52 (“[T]he volume ratio of the inorganic particles to the binder in the porous film is in a range of 0.2 to 3.0”). Thus, as explained in my Preliminary Declaration, “[a] POSITA would have understood the above teachings to mean that the relative amount of binder and its method of solidification (e.g. coagulation) dictate how the pores are formed and the structure of the pores, including size” in the ’148 Patent. *Id.*

55. Fourth, that the pore walls are claimed to be made of binder, and thus meaning that the pores are *not* the “interstitial cavities between the relatively tightly packed particles,” is further evident based on the language of certain dependent claims. Dependent claims 3 and 12 additionally require that the “average wall

¹ “In the words of the patent, the range 0.2-3.0 represents a range of $V_{\text{particles}}/V_{\text{binder}}$. To convert this to volume percentage of binder, which is the ratio $V_{\text{binder}}/(V_{\text{binder}}+V_{\text{particles}})$, I did the following algebra: $1/(1+3.0)$ to represent the low end of the range, and $1/(1+0.2)$ to represent the high end of the range. This amounts to 25 vol% to 83 vol% binder in the solid portion of the porous layer.” Ex. 2015 ¶ 80, n. 4.

thickness between the pores is in a range of 20 nm to 500 nm.” Ex. 1001 at 25:49-51, 26:33-36. This is the equivalent of 0.02 μm to 0.5 μm .² This range for wall thickness is much smaller than at least ten percent of the inorganic particles in the porous layer (Dv90 is in a range of 1 μm to 10 μm) and the vast majority of the ranges for Dv10 and Dv50 (Dv10 is in a range of 0.015 μm to 3 μm and Dv50 is in a range of 0.2 μm to 5 μm). Given this significant difference in described size between the walls and the inorganic particles, it would not make any sense for the claimed walls of the pores to *be* the inorganic particles. Instead, the specification explains the importance of the wall thickness being so small:

[S]ince the average wall thickness between the adjacent pores in the porous film is low, the binder (usually a polymer, for example, polyvinylidene fluoride) can be prevented from swelling in the electrolyte and blocking the pores of the porous film after the porous film is subjected to the soaking process in the electrolyte during the preparation of the lithium-ion battery. Therefore, the pore structure in the porous film can be more retained, smoothness of the lithium ion transport channel is ensured, and the polarization reaction inside the lithium-ion battery is reduced, thereby the rate performance of the lithium-ion battery can be further improved.

Ex. 1001 at 5:3-14.

² This is because each micrometer (μm), or “micron”, is equivalent to 1,000 nm.

56. Finally, there is nothing in the prosecution history that changes my opinion regarding the plain and ordinary of pores “formed by the binder.” There is no disclaimer, as the Patentee consistently argued that a reference in the prosecution history having pores formed between inorganic particles *does not* satisfy pores “formed by the binder.” Ex. 1014, 42. Thus, especially in light of the claim language and the rest of the specification, “a POSITA would have understood that “pores formed by the binder” means that it is the binder, including its relative amount combined with a particular method of coagulation, not the inorganic particles, that defines the formation of, and the boundaries of, the pores.” Ex. 2015 ¶ 82.

B. “The Pores at Least Comprises a Part of the Inorganic Particles”

57. The parties also dispute the plain and ordinary meaning of “the pores at least comprise a part of the inorganic particles.” In his declaration filed with the Petition, Dr. Gido opined that this limitation is necessarily met by the Murakami reference because “Murakami’s porous layer is predominantly composed of inorganic filler, with a filler-to-binder weight ratio of 97:3 in Example 1 and 2.” Ex. 1003 ¶ 97. Given the overwhelming amount of inorganic particles, Dr. Gido stated that “a POSITA would understand that the pores in Murakami’s porous layer necessarily include at least some portion of the inorganic filler or would have found this obvious.” *Id.* I disagree. As I explained in my Preliminary Declaration, in Murakami the pores “are formed by gaps between the inorganic particles.” Ex. 2015

¶ 99. This means that the inorganic particles themselves do not (and cannot) be part of the pores like they are in the '148 Patent. In other words, in Murakami, the “pore” would be the space between inorganic particles—not the particle themselves. If anything, the inorganic particles could only be considered the lines that demarcate where the pore is.

58. In the Institution Decision, I understand the Board concluded that the claim language, “the pore at least comprise[] part of the inorganic particles,” is broad enough to encompass examples where the inorganic particles are part of the pore wall but not the pore itself. Paper 10 at 19. In other words, the Board concluded that this language does not require the inorganic particle to extend into the pore. *Id.*

59. Respectfully, I disagree with this overly broad reading of the claims. I understand that the Board expressly noted that “[t]he parties may address the claim construction of this limitation in their briefing during trial,” and I do so below.³

³ I also provided a brief discussion of the plain meaning of this term in Paragraphs 97-99 of my Preliminary Declaration (Ex. 2015), and I incorporate by reference that discussion herein. Given the Institution Decision’s apparent adoption of Petitioner’s construction, however, I provide additional analysis below to explain how a POSITA would have understood the plain and ordinary meaning of this term.

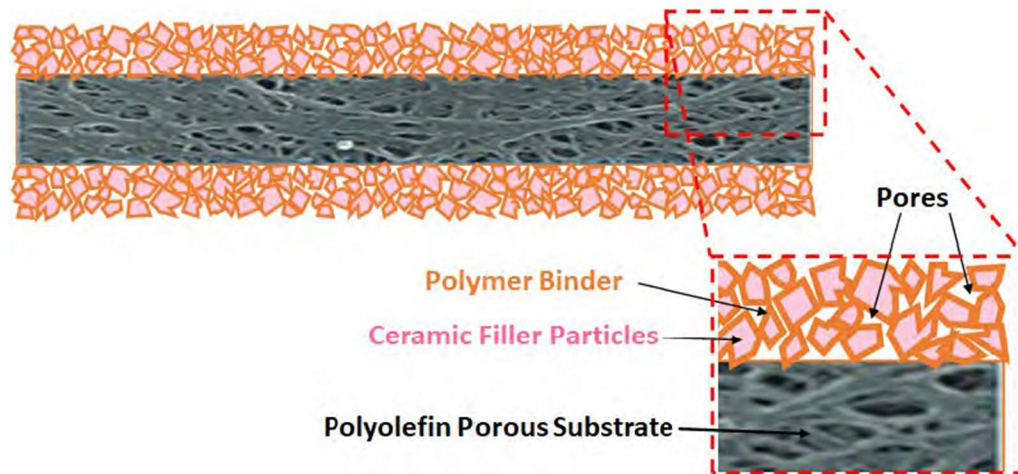
60. First, I have reviewed the declaration of Dr. Quinn Horn regarding the correct construction of this term, and I agree with and incorporate by reference his testimony regarding the correct grammatical construction of that term under the plain and ordinary meaning. Ex. 2045 (Declaration of Dr. Quinn Horn) ¶¶ 52-60. Accordingly, I incorporate for purposes of my analysis below a grammatical correction to the term that represents how a POSITA would understand the term, and I interpret “the pores at least comprises a part of the inorganic particles” as “the pores at least comprise a part of the inorganic particles.” I note that Dr. Guido appears to agree that this grammatical correction is accurate and does not impact his opinions. Ex. 2033 (Guido Depo. Tr.) at 12:4-13:1.

61. Second, I disagree with Dr. Guido and the Institution Decision’s preliminary conclusion that the claimed “pore” includes the pore’s walls. Rather, a POSITA would have understood the plain and ordinary meaning of “pores” to mean voids or interstitial spaces. In other words, the plain and ordinary meaning of the term “pore” does not include the physical walls that define the outer limits of the pore—the “pore” is the space *between* those walls. Dr. Guido disagrees with me, arguing instead that the plain and ordinary meaning of the term “pore” includes both the void and the physical walls of the pore. *See, e.g.*, Ex. 2033 at 51:6-13. However, Dr. Guido’s interpretation cannot be the plain and ordinary meaning of “pore” at least because it contradicts (1) Dr. Guido’s own testimony, (2) the plain use of “pore” in

the context of “porosity,” (3) the plain use of “pore” in the ’148 Patent, and (4) the plain use of “pore” in Petitioner’s own cited prior art references and in Petitioner’s and Dr. Guido’s analysis of that prior art.

62. First, Dr. Guido’s construction of “pore” in this proceeding contradicts his prior testimony in an IPR between the same parties involving a family member of the ’148 Patent. In his declaration filed with the Petition in that proceeding, Dr. Guido used the terms “pore” and “void” interchangeably, correctly stating that stretching a polyolefin “opens up voids or pores in the film.” Ex. 2031 ¶ 41. He also testified that, in separators having a high volume of ceramic materials, “[t]he interstitial space between the particles is connected into tortuous pores.” *Id.* ¶ 48. He further explained that, in separators having “high particle loadings up to as much as 90% weight, or more,” “the porosity is a result of the interstitial cavities between the relatively tightly packed particles.” Ex. 2031 ¶ 52. These statements make clear that Dr. Guido previously understood the word “pore” to be synonymous with “void” or “interstitial space,” such that it does not include the physical walls surrounding that void or interstitial space.

63. Indeed, when illustrating the “pore” in his declaration, Dr. Guido annotated the void or interstitial space between binder walls as the “pore,” separately annotating the orange binder walls as “polymer binder” and the pink jagged pieces surrounded by binder as “ceramic filler particles.”



Ex. 2031 ¶ 53.⁴

64. Even during his deposition, though he argued the definition of pores includes the walls when looking at the claim language, Dr. Guido said differently at least once when discussing the prior art, there defining a pore as the “volume *between* particles.” Ex. 241:14-242:2 (“So *the pores* are – yeah, *defined by the volume between these particles.*”) (emphasis added).

65. Second, Dr. Guido’s construction of “pore” in this proceeding contradicts how the term “pore” is understood in the context of “porosity.” Porosity represents the open space in a porous layer and is a key measurement because it is indicative of how effectively ions can be transferred from one side of the layer to the

⁴ Dr. Guido provided this same illustration at Paragraph 33 of his Declaration, Ex. 1003.

other. As Dr. Guido admitted in his deposition, porosity is a percentage between 0 and 100% that is calculated by “divid[ing] the empty space by the total size.” Ex. 2033 at 44:5-12. In other words, 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.” *Id.* at 44:13-21.⁵ When measuring “the numerator that is the volume of space that is the pores,” a POSITA does not include the volume of the walls. *Id.* at 44:22-45:9; *see also* discussion *infra* at Paragraph 71.

66. Third, Dr. Guido’s construction of “pore” in this proceeding contradicts the plain use of the term in the ’148 Patent. The ’148 Patent clearly states, “since the average wall thickness *between* the adjacent pores in the porous film is low . . .” Ex. 1001, 3:30-32. Thus, according to the specification, the pore *walls* are not a part of the pore but are instead located *between* the pores. This “between” language is used

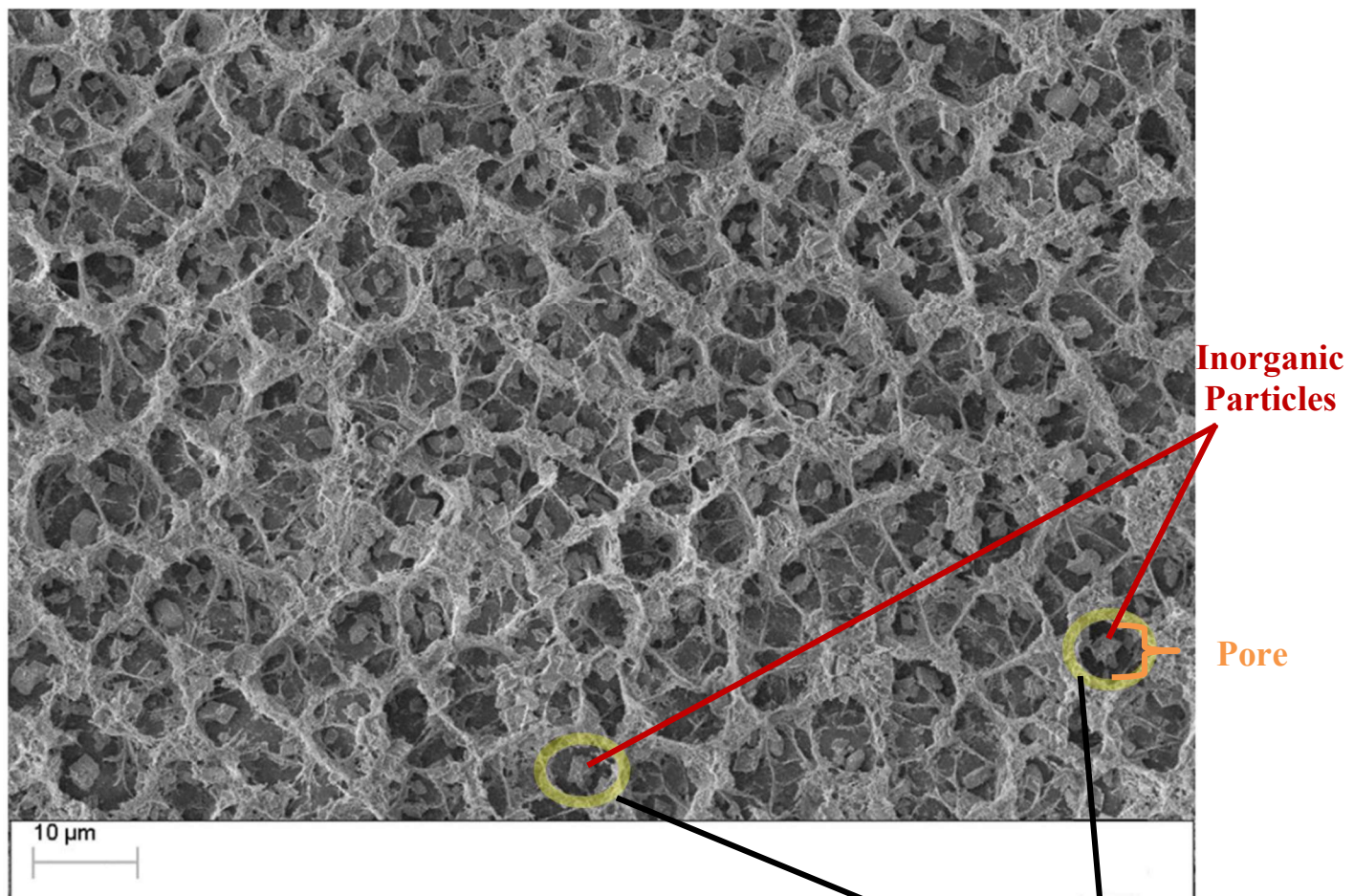
⁵ It is also common for a porous layer to exhibit “nanoporosity,” in which there are very small pores that can contribute to the total pore volume in the numerator. These nanopores are much smaller pores (i.e. voids or interstitial spaces) that are often enclosed or disconnected from other pores and therefore less accessible to ions. The small pores also create strong molecular interactions with walls, so they do not allow significant passage of ions. The physical walls that surround those very small spaces are not included in the definition of “nanopore,” either.

throughout the '148 Patent, including in the dependent claims. *See, 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.

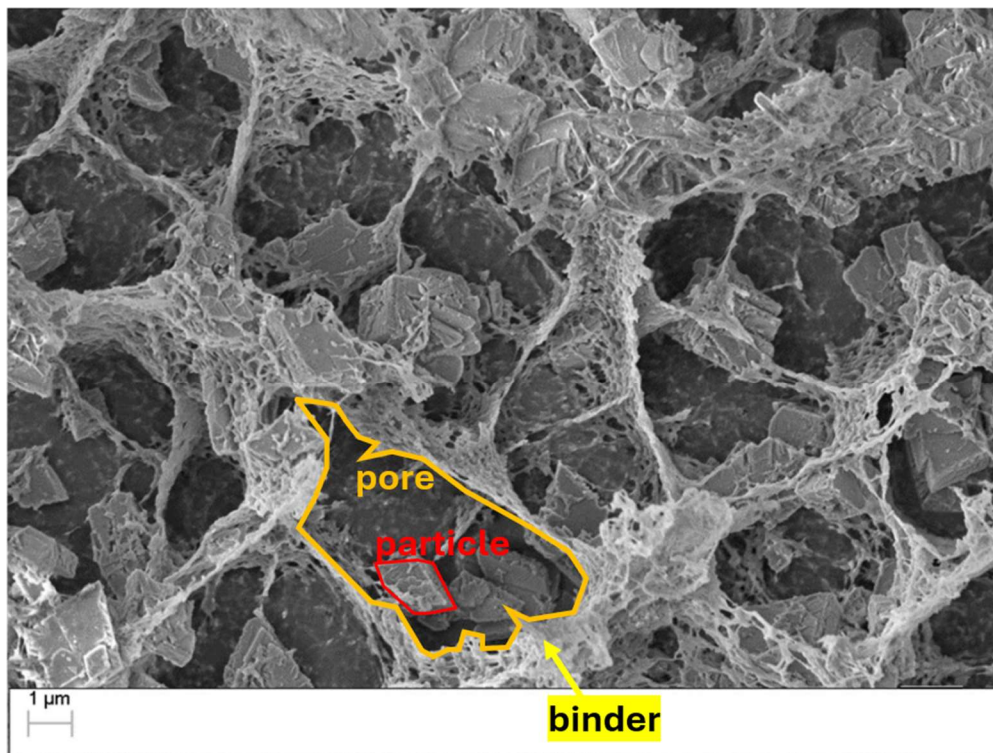
67. The specification is explicit throughout that the inorganic particles are a separate component from the pore walls, which are made of (and defined by) the binder. For example, the '148 Patent makes clear that “average pore wall thickness” and particle sizes are separate and distinct measurements from “average pore size.” It explains that “large pore structures are formed in the vicinity of the inorganic particles, and the pore structures with large average pore sizes and small average wall thickness between adjacent pores are easily obtained.” Ex. 1001 at 3:64-67. The independent claims specify the size distributions of the inorganic particles, and certain dependent claims add an additional, distinct requirement for wall thickness between pores (Claims 3 and 12). Moreover, other dependent claims specify yet another requirement: average pore size (Claims 2 and 11). Thus, the '148 Patent does not include the pore walls in its understanding of what constitutes the pore (which has its own, different dimensions from both the inorganic particles and the pore wall). Indeed, the patent sets forth an average wall thickness between 0.02 μm and 0.5 μm , but also requires at least some of the inorganic particles to be much larger, for example at least 1 μm to 10 μm to satisfy Dv90. *See, e.g., Ex. 1001, e.g., Ex. 1001, 1:45-50, 4:61-64, 6:7-13, 25:33-51).* This is even more support for the fact

that the inorganic particles must extend into the pores and cannot solely be a part of the walls between pores.

68. An example of this plain meaning of “pores at least comprise[] part of the inorganic particles” is illustrated using SEM images in the specification. The patent provides multiple SEM images that depict pores that have boundaries delineated by the stringy binder and into which inorganic particles at least partially extend. This is evident from the annotated version of Figure 1 provided below (this is a higher resolution version of Figure 1 from the file history, Ex. 1002).



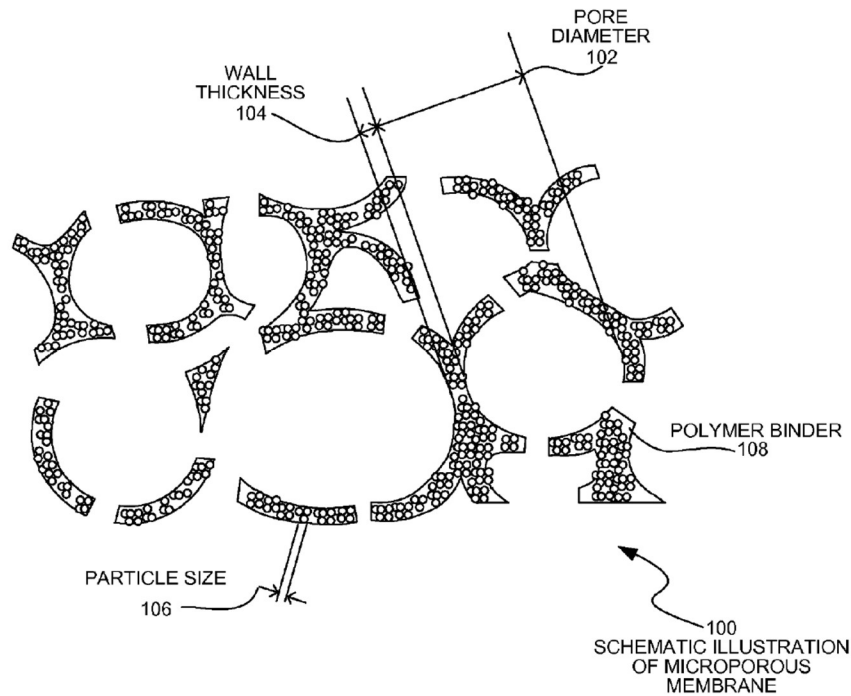
69. This is also clearly depicted in Figure 2, a zoomed-in SEM image of the claimed porous layer. I have provided an annotated version of a higher resolution version of Figure 2 below (from the file history of the '148 Patent, Ex. 1002). As shown in this figure, the binder stretches out during coagulation to form the boundaries of a pore (i.e. the binder is the pore wall), and an inorganic particle extends inside that pore.



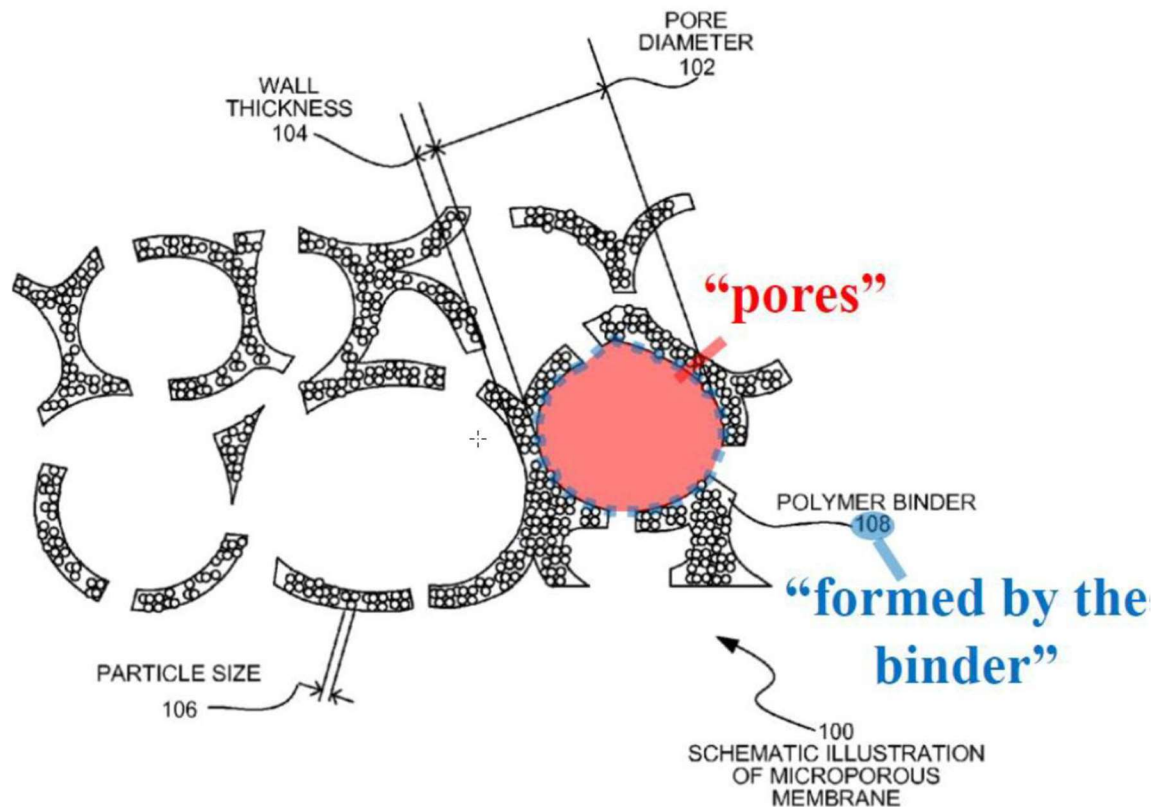
70. In this way, the specification confirms the plain meaning of the claim language explained above. Namely, that there are two independent requirements for the pores in the porous layer: first, the pore must be “formed by the binder” (i.e. the

pore walls are made of binder, which in turn delineate where one pore ends and another pore begins); and second, the pore must include at least part of an inorganic particle (i.e. the inorganic particles must extend at least partially into the space delineated by the binder walls). In other words, the plain and ordinary meaning of “pore” does not include the wall of binder that delineates the outer boundary of that pore.

71. Finally, Dr. Gido’s construction of “pore” in this proceeding contradicts the plain use of the term in Petitioner’s cited prior art references and in Petitioner’s and Dr. Gido’s analysis of that prior art, as well as other well-known art. In Beard, for example, Figure 1 defines the “pore diameter” 102 as extending from the inside of one pore wall to the inside of the other, and *not* including the pore walls themselves (in the same way that the measurements of a room’s dimensions in a house do not include the thickness of the walls in their measurement of the room). Instead, pore walls are considered a separate component that have their own measurement: “wall thickness 104.” *See also, e.g.*, Ex. 2051 (“Pore size refers to the diameter of the void spaces within a material.”).



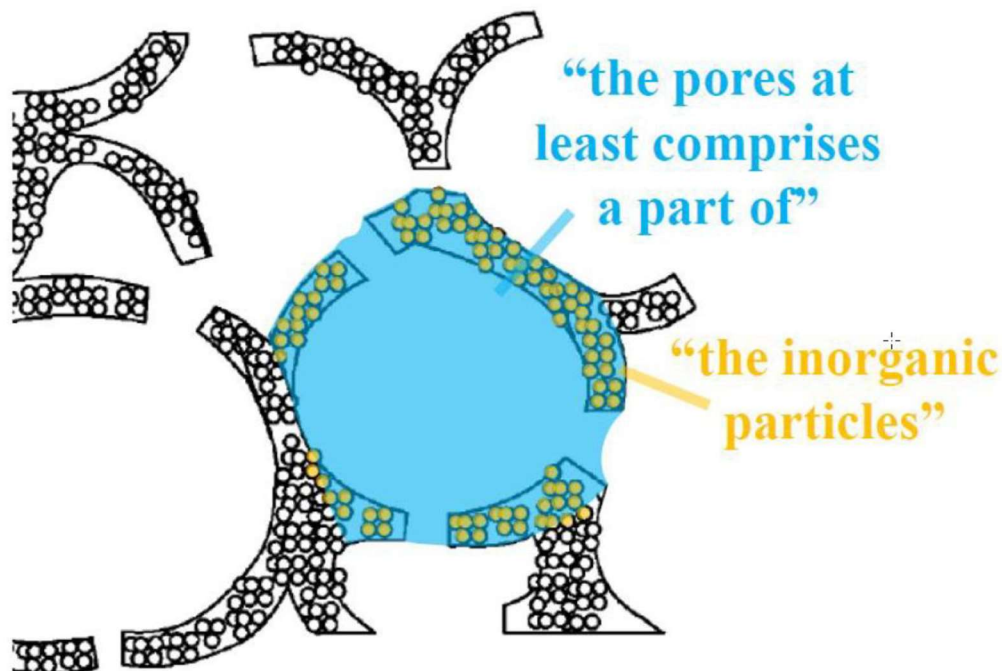
72. Petitioner appears to agree with that understanding of “pore” when applying the prior art to the limitation “pores formed by the binder.” In particular, Petitioner provided the below annotated drawing that defines the pore *separately* from the pore walls in Beard.



Paper No. 2 (Petition) at 50. Petitioner’s annotations above add annotations of particles that are not actually depicted within the pores, and irreconcilably conflict with Dr. Guido’s separate figure where he contends that the “pore” *includes* the pore walls. Ex. 1003 ¶ 174 (Dr. Guido’s annotated figure, addressed and depicted further below).

73. Nevertheless, Petitioner changes its construction of the “pore” when applying the prior art to a different limitation: “pores at least comprise a part of the inorganic particles.” There, Petitioner argues that the inorganic particles are part of the pore because they are located inside the pore walls, which they inconsistently

now contend constitute part of the pore itself. *Id.* at 52. In doing so, Petitioner expands the definition of “pore” beyond what Beard discloses, beyond what a POSITA would understand a pore to mean, and beyond what Petitioner previously defined as the pore for purposes of the previous limitation—by providing the below annotated version of Figure 1.



Beard, FIG. 1*

74. Petitioner should not be permitted to have two different and inconsistent constructions of what constitutes the pore for different claim limitations within the same claim—one where the pore is only the red circle (not including the pore walls) and a different one where the pore is the blue circle (including the pore walls). Instead, the Board should apply the plain and ordinary meaning of the term,

where the pore does not include the pore walls. As I have explained, this meaning is required by the claim language and the specification, it is confirmed by Petitioner's own reference (Beard), it is confirmed by Dr. Gido's previous testimony in a different IPR, and it is even confirmed by Petitioner's own interpretation of Beard when applying it to limitation [1.3] pores "formed by the binder." Moreover, nothing in the prosecution history changes the plain and ordinary meaning for the same reasons set forth above regarding pores "formed by the binder."

C. Dv10, Dv50, Dv90 in the Porous Layer

75. The parties also dispute the plain and ordinary meaning of the inorganic particle size distribution limitations, which require a "porous film, comprising . . . inorganic particles . . . wherein the inorganic particle have particle sizes that Dv10 is in a range of 0.015 μm to 3 μm , Dv50 is in a range of 0.2 μm to 5 μm , and Dv90 is in a range of 1 μm to 10 μm ." The Petition and Dr. Gido's declaration appear to hold the position that, so long as the inorganic particles used to make a porous film have these Dv10, Dv50, and Dv90 values *at any point* during the process of making the film, then this limitation is satisfied. *See, e.g.*, Ex. 1003 (Gido Decl.) ¶ 111 (citing to the D10, D50, and D90 values of the starter filler material, before mixing and dispersion); Paper 2 at 31-32 (same). However, Dr. Gido appeared to walk back this position about the meaning of the claim language in his deposition, admitting that the claimed particle sizes are the particle sizes as they exist in the porous layer. Ex.

2033 at 168:12-169:19 (“Q: The claim of the 148 patent is asking about particle sizes as they exist in the layer, correct? . . . A: *It – you know, the claim says what it says.* . . . I don’t think it was the inventor’s intention, you know, I don’t think that they measured them in the – in their film they measure what they put in the film like everybody else does. *But the claim says what it says and so, you know, we can have this discussion.*”) (emphasis added); *id.* at 170:21-171:18 (“Q: And so the measurement of particle size distribution, if taken before that ball milling or before pulverization, would not apply to the particle sizes in the porous film, correct? A: Right, yes.”).

76. As explained in my Preliminary Declaration, I disagree with Petitioner’s interpretation that, so long as the inorganic particles used to make a porous film have these Dv10, Dv50, and Dv90 values at any point during the process of making the film, then this limitation is satisfied. Ex. 2015 ¶¶ 101-103. It is my opinion that the plain and ordinary meaning of this claim language requires the recited Dv10, Dv50, and Dv90 values to be satisfied by the inorganic particles that are *in* the porous film. The “porous film” is the finished product: the layer having a binder, pores, and inorganic particles. The inorganic particles must have the claimed Dv10, Dv50, and Dv90 values when they are in that film to satisfy this claim limitation.

77. I understand that the Board requested that the parties “address this claim construction during the trial.” ID at 20. I do so below.⁶

78. First, the claim language dictates that the Dv10, Dv50, and Dv90 values must be satisfied by the particle sizes of the particles when they are in the porous layer. The claim requires a *porous layer comprising* “inorganic particles,” and those inorganic particles that are comprised by the porous layer provide the antecedent basis for “*the* inorganic particles” that the claim further requires to “have particle sizes that Dv10 is in a range of 0.015 μm to 3 μm , Dv50 is in a range of 0.2 μm to 5 μm , and Dv90 is in a range of 1 μm to 10 μm .” As I explained in my Preliminary Declaration, “[t]his language does not talk about inorganic particles generally but instead recites inorganic particles sizes in the context of the porous film having pores, implying that the inorganic particles sizes of the particles that themselves comprise a part of the pore. The fact that the claimed particles sizes are of ‘the’ inorganic particles included in a limitation that requires ‘the’ inorganic particles to be part of the pores shows that those are the particle size ranges for the particles *in the porous layer*.” Ex. 2015 ¶ 102.

⁶ I also provided a brief discussion of the plain meaning of this term in Paragraphs 101-103 of my Preliminary Declaration (Ex. 2015), and I incorporate by reference that discussion herein.

79. This plain and ordinary meaning of the claim language is confirmed by the specification. The '148 Patent is clear that the recorded Dv10, Dv50, and Dv90 values correspond to the actual size of the inorganic particles when they are in the finished porous film for at least two reasons. First, the placement of where the Dv10, Dv50, and Dv90 distribution values are recorded in the specification heavily implies that these are the measurements of the inorganic particles when those particles are in the porous film. Each of the examples in the '148 Patent includes a section describing the "preparation of separator." *See, e.g.,* Ex. 1001 at 12:16-35. This section begins by identifying which types of inorganic particles (e.g. boehmite) and binder (e.g. polyvinylidene fluoride) were used to create the separator, as well as the volume ratio of the two. *See, e.g., id.* at 12:16-20. The section then goes on to describe in detail the NIPS process used to develop the porous film on the porous substrate, including details such as which solvents were used and what temperature the separator was dried at after being immersed in the coagulation solution (i.e. non-solvent). *Id.* at 12:21-32. Finally, it is not until the very end of this section that the specification states: "[t]he particle size distribution of inorganic particle (boehmite) is such that Dv10 is 0.9 μm , Dv50 is 1.8 μm and Dv90 is 3.0 μm ." *Id.* at 12:33-35. The fact that the inventors did not specify the particle size distributions for the inorganic particles until *after* the entire process was finished indicates to a POSITA that the recorded particle sizes reflect the actual sizes of the particles in the finished

porous film. Otherwise, if all that mattered was the particle size distributions of the starting inorganic particles, a POSITA would expect these “preparation of separator” sections to simply include the distributions at the beginning when they first specify the type of inorganic particle used as a starting material.

80. Second, even if the recorded values in the patent were meant to indicate the starting particle size distributions of the inorganic particles, a POSITA would have understood the starting particle size distributions in the '148 Patent to *also* reflect the final particle size distributions because there is nothing in the '148 Patent's manufacturing process that involves significantly altering the sizes or distribution of sizes of the particles when manufacturing the separator. Thus, for the '148 Patent, a POSITA would expect the starting particle size distributions to be essentially the same as the final particle size distributions. As I will explain below in Section VII.A.3, this is in sharp contrast with references like Murakami, which involve a high-pressure dispersion step that subjects the inorganic particles to three passes of 100 MPa high pressure (roughly 1000 times atmospheric pressure, which a POSITA would understand would necessarily result in significant fracture of alumina materials and breakup of agglomerated alumina particles) during the process of manufacturing the separator. For Murakami (and other references that involve similar extremely high-pressure dispersion methods), a POSITA would not—and could not—assume that the measured initial particle size distributions

before manufacture are the same as the final particle size distributions in the finished porous layer.

VII. THE CHALLENGED CLAIMS ARE NOT UNPATENTABLE

81. I understand that in an *inter partes* review, Petitioner bears the burden of proving by a preponderance of the evidence on a claim-by-claim basis for each challenged claim that such a claim is unpatentable over the prior art. For at least the reasons explained in Paragraphs 71-178 of my Preliminary Declaration (Ex. 2015)⁷ and in view of the additional explanation provided below, it is my opinion that none of the challenged claims are unpatentable.

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

82. It is my understanding that in Ground 1, Petitioner contends and Dr. Gido opines that Murakami renders obvious Claims 1, 2, 5-11, and 14-19 of the '148 Patent. Pet. at 19-41; Ex. 1003 at 35-67. In particular, I understand that Dr. Gido opines that Murakami's general disclosure, Example 1, and Example 2 each independently disclose or render obvious Claims 1, 2, 5-11, and 14-19 of the '148 Patent. Dr. Gido does not rely on other examples of Murakami for his opinions. To

⁷ I incorporate by reference herein my Preliminary Declaration in full (Ex. 2015), including but not limited to Paragraphs 71-178.

the contrary, Dr. Guido argues that a POSITA would be motivated to use Examples 1 and 2 of Murakami over all the other examples in Murakami. Ex. 1003 ¶ 80 (Dr. Guido opining that, “of all Examples, Examples 1 and 2 had the smallest voidage variability” and “exhibited the best capacity retention,” and thus “their superior performance would have enticed a POSITA to implement these Examples rather than attempt to prepare a laminated body having other features or characteristics.”).

83. I disagree that Murakami discloses or renders obvious the claimed invention, whether through its general disclosure or through Examples 1 or 2.

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

84. Dr. Guido opines that Murakami discloses “wherein the porous film comprises pores formed by the binder” for two primary reasons: (1) Murakami states that it has a porous layer in which “the filler is *bound by* the binder resin” (Ex. 1003 ¶ 90 (quoting Ex. 1005 ¶ [0070])) (emphasis added); and (2) “Murakami forms those pores through a process like that described in the ’148 Patent” (Ex. 1003 ¶ 94).

85. The Board appears to have at least preliminarily accepted these arguments in its Institution Decision. Paper No. 10 at 16-18. Respectfully, I disagree that Murakami discloses this limitation.

a. Murakami Discloses that Its Pores Are Formed by Gaps Between Its Inorganic Particles, *Not* by the Binder

86. Dr. Gido and the Petition rely on Murakami’s disclosure in Paragraph 70 that “the filler is bound by the binder resin.” Ex. 1003 (Gido Decl.) ¶ 90; Paper 2 (Petition) at 23. But this disclosure does not establish that the pores in Murakami are “formed by the binder.” Instead, this disclosure and the rest of Murakami establish the opposite—that the pores are *not* formed by the binder but instead are formed by inorganic particles.

87. As explained above in Section IV.A, the plain and ordinary meaning of “pores *formed by the binder*” requires the binder to delineate the boundaries of the pores, rather than some other component of the porous layer. This is not the case in Murakami.

88. First, Murakami itself states that the pores in its porous layer are *not* formed by the binder but instead are formed by Murakami’s inorganic particles. Paragraph 69 of Murakami states that the pores are “*gaps formed by contacts of particles of the filler*,” (i.e. the pores are formed by the inorganic particles):

In a case where the porous layer contains a filler, *a filler content is preferably 1 volume % to 99 volume %, more preferably 5 volume % to 95 volume %, relative to the porous layer. In a case where the filler content is within the above range, gaps formed by contacts of particles of the filler are less likely to be blocked by a resin and the like*, and it

is therefore possible to obtain a sufficient ion permeability and an appropriate weight per unit area.

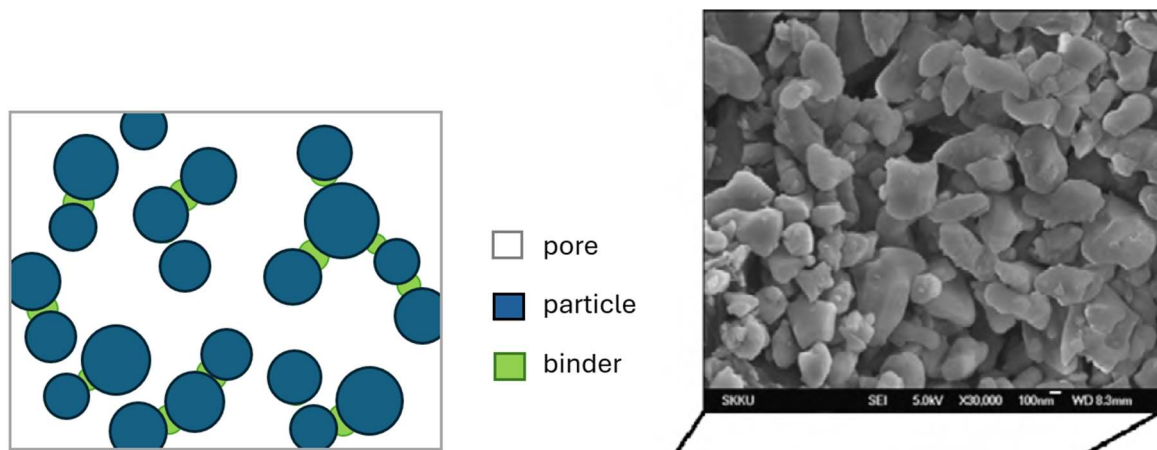
Ex. 1005 at [0069] (emphasis added).

89. It is important to note that 1 volume % filler does not mean that the porous layer has 1% by volume filler and 99% by volume binder. Rather, the total percent volume must account for all other components of the porous layer, including the pores or voids themselves. Thus, 1 volume % filler could mean, for example, 1 volume % filler, 0.1 % volume binder, and 98.9 % volume void.

90. Moreover, while Dr. Gido took the position during his deposition that Murakami teaches “a broad range” of filler (Ex. 2033 at 244:13-245:2), in his declaration he testified that “in the description of the general embodiment, Murakami states that the filler content makes up most of the filler-binder combination by weight, preferably up to 99 wt%.” Ex. 1003 ¶ 99. He also testified that “Murakami’s binder composition consist[s] of nearly *all* filler” (*id.* ¶ 101), and that a POSITA would have been motivated to use the filler amounts in Examples 1 and 2 (which are 97% by weight filler, or 93% by volume) (*id.* ¶¶ 100). As Dr. Gido conceded during his deposition, Examples 1 and 2 have “high ratios of filler to binder.” Ex. 2033 at 244:13-245:2.

91. If one were to depict the pore structure of Murakami’s porous layer using the same style of illustration provided in my background section above, the

pore structure of Murakami's Example 1 and Example 2 (which use only **3 parts** by weight of binder compared to **100 parts** by weight of filler, that is, more than 97 weight% filler (Ex. 1005 ¶¶ 141, 161)) would look something like the illustration on the left, below, with gaps formed between its filler particles. An exemplary SEM image of a high-loading particle layer that a POSITA would expect to be similar in structure to Murakami is provided on the right, below. Ex. 2052 at Fig. 2.



92. The drawing on the left is meant to illustrate a slice or thin planar section of the structure and is not exact in every particular geometric feature or scale. For instance, inorganic particles are never perfect spheres shown here as circles. Nevertheless, for the purposes of this illustration, I assumed the same density for the inorganic particles, α -alumina (density 3.97 g/cm³), and the binder, sodium carboxymethyl cellulose (density 1.6 g/cm³), as Dr. Guido used in his declaration. Ex. 1003 ¶ 100. That means that there are 7.4 parts by volume binder resin for every 100

parts by volume of inorganic particles. *Id.* For the above illustrative slice, this volume ratio is likewise given in the area ratio between binder and particles. The SEM image on the right is provided because it provides high depth of field so one can see the particles below the pores, for instance.

93. Murakami's description of its pores as "gaps formed by contacts of particles in the filler" is consistent with Dr. Gido's own previous statements where he testified (in connection with a separate IPR) that in porous layers with high particle loadings (for example, at least 90% filler, like Murakami), that "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 interstitial cavities between the relatively tightly packed particles," which he contrasts with layers that have lower percentages of particles and higher percentages of binder (above 50% binder). Ex. 2031 ¶ 52.

94. As explained in Paragraph 50, this is the exact type of pore structure the claims of the '148 Patent differentiate from when they add the requirement that the pores must be "formed by the binder."

95. Second, that Murakami's pores are formed by the inorganic particles, and not by the binder as required by the claims, is further confirmed by the fact that Murakami teaches a POSITA that it is most preferable to use only a minimal amount of binder relative to the amount of filler. As explained in Paragraph 54, a POSITA

would have understood that, for pores to be formed by the binder, there must be a significant relative amount of binder in the porous layer. The '148 Patent, for example, teaches using at least 25% binder (and up to 83% binder). *See* Ex. 2015 ¶ 54.

96. Murakami teaches a POSITA to do the exact opposite. It teaches preferably minimizing the amount of binder used, stating that much lower relative percentage of binder—preferring *as little as 1 mass % binder* and not more than 10 mass % binder (that is, 99 mass % filler, and not less than 90 mass % filler)—are the most preferred:

In the porous layer containing the filler and the binder resin, a filler content is preferably 60 mass % or higher, more preferably 70 mass % or higher, further preferably 80 mass % or higher, *most preferably 90 mass % or higher, and preferably 99 mass % or lower*, relative to a total mass of the porous layer.

Id. ¶ 70 (emphasis added).

97. In Examples 1 and 2 of Murakami, which Petitioner and Dr. Gido rely on as the examples a POSITA would use, Murakami teaches using only *3 parts* by weight of binder compared to *100 parts* by weight of filler. Ex. 1005 ¶¶ 141, 161. And in his declaration, Dr. Gido states that in Murakami “the porous layer consists of *nearly all filler material* and *relatively little [binder] resin* by weight.” Ex. 1003

¶ 103 (emphasis added). I understand the Board accepted that characterization of Murakami in its Institution Decision. Paper No. 10 at 18-19.

98. Taking this characterization as true, it necessarily follows that a POSITA would understand that the pores in Murakami are **not** formed by the binder. A POSITA would have understood that there is simply not enough binder in Murakami's porous layer to surround the empty spaces and form pores, nor to fully surround the inorganic particles. Ex. 1003 ¶ 101 (Dr. Guido testifying that "[t]here is **simply not enough resin material** to completely subsume the much greater amount of filler—**just enough** for 'the filler [to be] bound by the binder resin.'"") (emphasis added). A POSITA would have looked at the minimal amount of binder used, together with Murakami's disclosure of "gaps formed by contacts of particles of the filler," and concluded that the pores in Murakami must be precisely what Murakami says they are: interstitial cavities, or "gaps" between inorganic particles, **not** voids formed between pore walls of binder.

99. Third, while Dr. Guido and Petitioner cite Paragraph 70 as evidence that this limitation is met, Paragraph 70 of Murakami serves only to confirm that Murakami's pores are **not** formed by the binder resin and that Murakami expressly did not want to create a porous layer using the binder resin:

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 ¶ [0070] (emphasis added). This disclosure in Murakami confirms what a POSITA would have already understood based on the minimal amount of binder and disclosure in Paragraph 69: the filler is *not* “dispersed in a [binder] resin.” Instead, as I explained in my Preliminary Declaration, a “POSITA would have understood based on this paragraph that the purpose of the binder resin in Murakami is to attach to the filler so that ‘the filler is bound by the binder resin’ as opposed to being dispersed in the binder resin.” Ex. 2015 ¶ 87.

100. Thus, while a POSITA would be unable to know the pore structure of Murakami for certain without looking at SEM images of its structures (as explained in Paragraphs 83-85 of my Preliminary Declaration), if anything, a POSITA would understand from Murakami’s disclosures that the pores in Murakami’s layers (particularly in Examples 1 and 2, which are 97% filler particle and only 3% binder) are formed by the gaps in between inorganic particles. Thus, the pores would be formed by the inorganic filler particles—not the binder.

b. Murakami’s Process of Making the Porous Layer Is Different than the ’148 Patent and It Does Not Create “Pores Formed by the Binder”

101. Dr. Guido and the Petition also argue that Murakami discloses “pores formed by the binder” because, according to them, Murakami discloses essentially

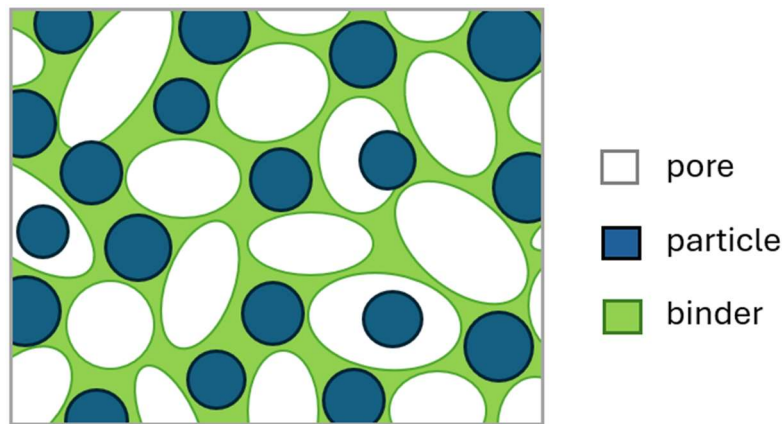
the same process of forming a porous layer as the '148 Patent. Ex. 1003 (Gido Decl.) ¶¶ 91-94; Paper 2 (Petition) at 23-25. I understand that the Board accepted that representation from Dr. Gido in its Institution Decision. Paper No. 10 at 17-18.

102. Respectfully, this interpretation of Murakami is incorrect. As I will explain below, Murakami uses a simple drying process that varies significantly from the NIPS process described in the '148 Patent, and in fact, Murakami teaches that a solvent substitution method like NIPS is less favorable than Murakami's drying process. Thus, a POSITA would have understood from Murakami that they should follow Examples 1 and 2 by using the simple drying process—and not a solvent substitution or phase separation process like NIPS—when forming a porous layer.

103. As explained in Paragraphs 93-96 of my Preliminary Declaration, the '148 Patent discloses forming a porous layer using the NIPS process. The key step in forming the pores using the NIPS process 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. This process of coagulation 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.* at 3:64-67. It is not

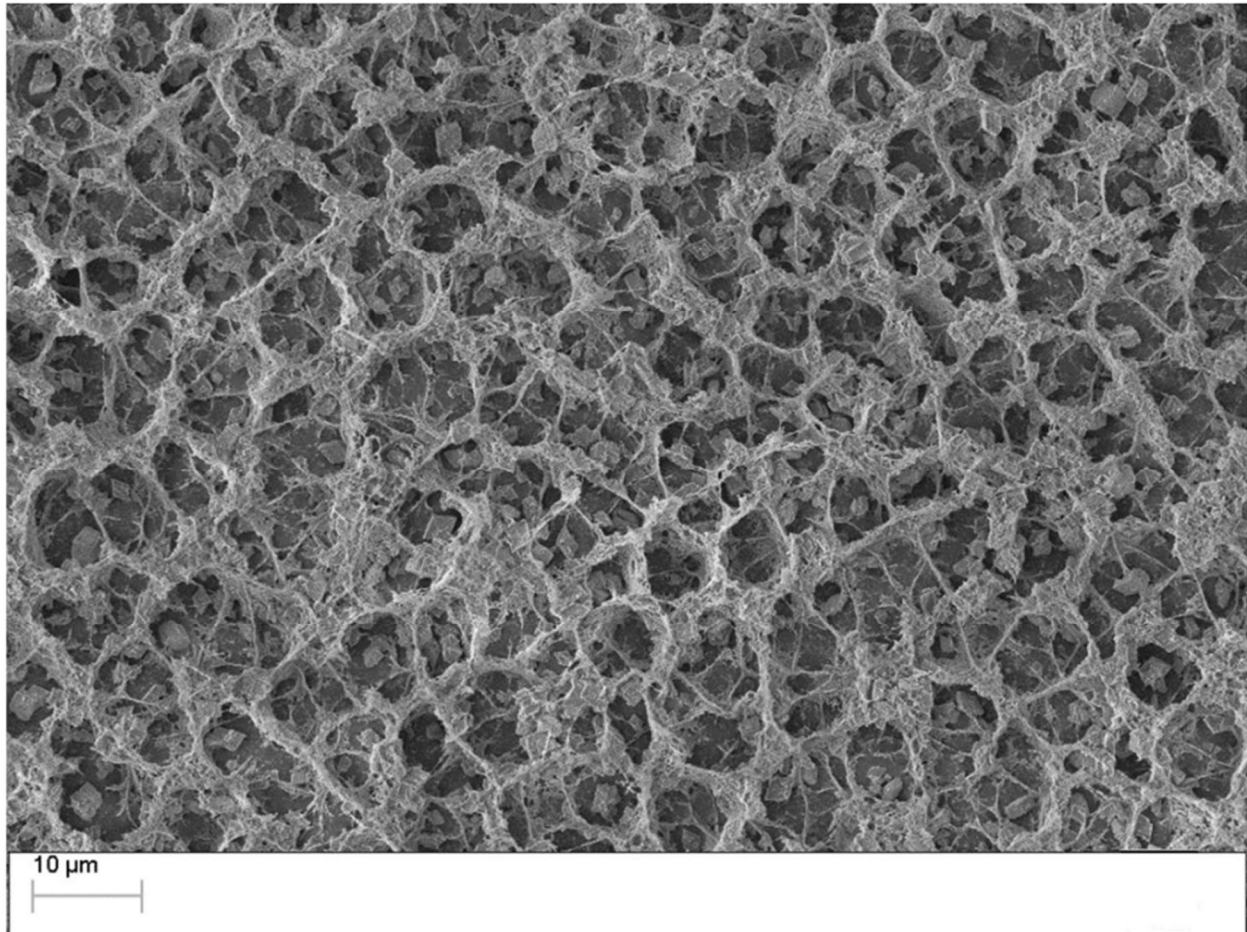
until after the coagulation (or pore formation) process is complete that the porous layer is dried in the '148 Patent. *Id.* at 6:7-13.

104. To use the same style of illustration provided above, a POSITA would have understood a slice or thin planar section of the resulting porous layer of the '148 Patent to look something like this:



105. Again, this drawing is meant to be illustrative of the arrangement of particles and binder leading to the pore structure. While not exact in every particular geometric feature, such as precise shapes of particles and pores, the drawing is consistent with Example 3 in the 148 Patent, having around 53% porosity and a volume ratio of 1.2 between the inorganic particles (blue) and the binder components (green). This drawing is consistent with the SEM images of the porous layer for Example 3 provided in the patent, for example the high-resolution version of Figure 1 (below). Note that SEM images have a high depth of field and so show more than

a thin slice or section of the structure would show. Note also that the SEM image in Figure 1 is also not as “zoomed in” as the illustration I provide above.



106. Murakami does not teach coagulating the binder to form pores like in the '148 Patent. Dr. Gido cites to Murakami's disclosure of a phase inversion process to argue that Murakami's process is essentially the same as NIPS, but this is not so. In particular, the Petition's and Dr. Gido's declaration obfuscate the facts that (1) Murakami teaches adding phase inversion as an optional *alternative* to its primary process, which is just a simple drying process with no coagulation or solvent

substitution step; (2) Murakami only uses the simple drying process, and does not add a phase inversion process, in both the examples Dr. Guido relies on; and (3) Murakami teaches a POSITA **not** to use the optional alternative process (the phase inversion process) because solely using its simple drying process is purportedly better. Moreover, even if Murakami were to use a solvent substitution method followed by drying in Examples 1 and 2 (which they would not), the resulting pores of Examples 1 and 2 would still not be “formed by the binder” because of the extremely small percentage of binder used in those examples, for the reasons I discuss above.

107. Dr. Guido agrees that “Murakami discloses both a drying process and an optional solvent substitution process.” Ex. 2033 at 130:11-14. This is because, while Murakami briefly mentions that a phase inversion (or solvent substitution) process is “possible,” Murakami discloses the broad category of solvent substitution as an optional alternative to its drying-only method:

The *solvent (dispersion medium) is generally removed by a drying method*. The drying method can be air drying, air blow drying, drying by heating, drying under reduced pressure, or the like. The drying method can be any of methods, provided that the solvent (dispersion medium) can be sufficiently removed. *Alternatively*, it is *possible* to carry out drying after the solvent (dispersion medium) contained in the coating liquid is substituted by another solvent. The method in which the solvent (dispersion medium) is removed after being substituted by

another solvent can be a method in which, for example, with the use of another solvent (hereinafter, referred to as “solvent X”) which is to be dissolved in the solvent (dispersion medium) contained in the coating liquid and does not dissolve the resin contained in the coating liquid, the porous film or the Support which has been coated with the coating liquid is soaked in the solvent X, the solvent (dispersion medium) in the coating film on the porous film or the Support is substituted by the solvent X, and then the solvent X is evaporated.”

Ex. 1004, [0087] (emphasis added).

108. There is no dispute that adding in the solvent substitution process in Murakami is “optional.” Ex. 1003 ¶ 92 (Dr. Guido opining that, “[o]ptionally, before drying, ‘the coating liquid is substituted by another solvent’ that ‘does not dissolve the resin contained in the coating liquid.’”) (emphasis added). More than that, however, Dr. Guido concedes that the examples he relies on (Examples 1 and 2) both use *solely* the simple drying method—not a solvent substitution or phase inversion process like NIPS—to form the porous layer. Ex. 2033 at 130:15-131:8; *see also* Ex. 1001, [0143] (not disclosing using a solvent substitution method and providing only that “the coating film was dried and thus layer B was prepared.”); [0163] (same). This is in contrast to Example 3, which does use the optional solvent substitution method (Ex. 2033 at 131:9-11), and which Dr. Guido and the Petition do not rely on. In fact, as Dr. Guido pointed out in his deposition, Example 3 does not use inorganic particles in their porous layers at all. Ex. 2033 at 36:8-11. Importantly,

Dr. Gido and the Petition argue that a POSITA would **not** use Example 3 (which does use solvent substitution), but instead would be motivated to use Examples 1 and 2 (which do **not** use solvent substitution) because of their “superior performance.” Ex. 1003 ¶ 80.

109. That the preferred examples (Examples 1 and 2) opt to use the simple drying method, rather than a phase inversion process, makes sense in light of the rest of Murakami’s disclosure. Murakami expressly teaches that the simple drying method is preferable to the alternative process of using solvent substitution before drying. Ex. 1001, [0088] (“In the present embodiment, in particular, ***it is preferable to remove the solvent (dispersion medium) by the method in which a coating liquid is applied to a base material and then the coating liquid is dried so as to form a porous layer.*** According to the configuration, it is possible to provide the porous layer in which a degree of variability in voidage is small and which hardly has a wrinkle.”) (emphasis added). This teaches a POSITA not to use a phase inversion or solvent substitution process, such as NIPS, but rather to use the simple drying process used in Examples 1 and 2 of Murakami without any solvent substitution.

110. That Examples 1 and 2 do not use a phase inversion process is also explained by the fact that Examples 1 and 2 teach using very little binder. A POSITA would have understood that a phase inversion process works by coagulating out the ***binder (or resin)*** in the solution to form pores. This means that, for a phase inversion

process to work, there must be enough binder or resin in the first place. In the type of porous layer where the pores are formed by gaps between inorganic particles, there is only a very small amount of binder present to hold things in place, and so a POSITA would have understood that there is not enough binder for a phase inversion process to be effective. Even if a POSITA *could* theoretically form an extra pore or two in one of the beads of binder in this type of porous layer, a POSITA *would not* want to do so. This is because there is already sufficient porosity based on the gaps between inorganic particles, and the point of the binder in such a porous layer is to hold everything in place. Adding additional pores in the already small amounts of binder would lead to physical instability in the porous layer. Thus, a POSITA would have followed Murakami's instruction to *not* use a phase inversion process, such is the case in Examples 1 and 2.

111. Finally, even if a POSITA were to use the optional, alternative solvent substitution process discussed briefly in Murakami—which they would not, and Examples 1 and 2 expressly do not—phase inversion (or solvent substitution) represents a broad category of possible formation methods, of which NIPS (as used in the '148 Patent) is only one. Other types of phase separation methods include thermally induced phase separation (TIPS), vapor induced phase separation (VIPS), and solvent evaporation-induced phase separation (SIPS). *See, e.g.*, Ex. 2040 at 4-7; *see also* Ex. 2036, Fig. 3 (showing a dramatic variation in pore structure as a

consequence of a small change in the amount of non-solvent (water) vs. solvent (acetone) in the phase inversion process). Each of these other types of phase separation methods involve unique processes that vary from the NIPS process and would result in varying porous structures. *See id.*

112. Indeed, even within the narrower subcategory of NIPS, the resulting pore structure can vary depending on other factors, such as the types and amounts of solvents and other materials used. Ex. 2040 at 5 (“During the procedure of NIPS, many factors will affect the final morphology of porous membranes, such as the constituent of the casting solution, the composition of the solvent or coagulation bath, additives in the casting solution, the miscibility of the solvent and nonsolvent, *etc.*). Thus, a POSITA would not (and could not) assume that the resulting pore structure of Murakami is the same as the ’148 Patent *even if* Murakami had disclosed the NIPS process generally, for the above reasons and also due to the high percentage of filler (compared to binder) that Murakami teaches a POSITA to use.

113. Thus, it is my opinion that Murakami does not disclose, suggest, or otherwise render obvious pores “formed by the binder.”

2. Murakami Does Not Disclose or Render Obvious Pores “at least compris[ing] a part of the inorganic particles”

114. Dr. Guido opines that Murakami discloses or renders obvious “the pores at least comprise a part of the inorganic particles” because (1) “Murakami’s porous

layer is predominantly composed of inorganic filler,” and (2) Murakami’s porous layer has 10% of filler particles that are 1/3 of the porous layer’s thickness, “so it is inevitable that some of these particles extend into the pores.” Ex. 1003 ¶¶ 97-98. I understand that the Board credited this argument in its Institution Decision. Paper No. 10 at 18-19.

115. Respectfully, I disagree that this disclosure means Murakami discloses this element.

116. As set forth in Paragraphs 57-74, the plain and ordinary meaning of this claim element requires at least a part of the inorganic particles to extend into the pores whose boundary is delineated by the binder—not just into *any* pores, but into pores that have themselves been formed by the binder.

117. As explained above, the pores in Murakami are the gaps formed between the inorganic particles. In other words, the inorganic particles themselves operate as the pore *walls*, and there are no pores formed by the binder for the particles to comprise a part of. Ex. 2033 at 123:4-8, 230:7-20, 241:14-242:2. As explained in my Preliminary Declaration, “[t]his means that it would be impossible for the inorganic particles to extend into the pores themselves—the inorganic particles in Murakami will only ever be part of the pore *walls*.” Ex. 2015 ¶ 9.9 And as explained in Paragraphs 57-74, a “pore wall” and “pore” are two distinct elements. The pore

wall, by definition, is not a part of the pore but rather is the boundary that surrounds the pore.

118. This is a critical distinction between the pore structure claimed in the '148 Patent and Murakami's pore structure. The '148 Patent discusses multiple distinct measurements relating to the porous layer, including average pore size, the size of the inorganic particles, and the average pore wall thickness. *Contrast, e.g., Ex. 1001 at Claim 1 with Claim 2 with Claim 3.* Each of these is a distinct measurement with different results. As to pore wall thickness, the '148 Patent explains:

[S]ince the average wall thickness between the adjacent pores in the porous film is low, the binder (usually a polymer, for example, polyvinylidene fluoride) can be prevented from swelling in the electrolyte and blocking the pores of the porous film after the porous film is subjected to the soaking process in the electrolyte during preparation of the lithium-ion battery. Therefore, the pore structure in the porous film can be more retained, smoothness of the lithium ion transport channel is ensured, and the polarization reaction inside the lithium-ion battery is reduced, thereby the rate performance of the lithium-ion battery can be further improved.

Ex. 1001, 3:30-42.

119. Murakami does not mention pore "walls" at all, let alone provide measurements for the pore walls. This makes sense when you consider the pore

structure of Murakami, in which the pores are simply gaps between the inorganic particles (as explained in Paragraphs 88-100). Thus, the boundaries of the pores in Murakami are the inorganic particles themselves, and the “pores” are the gaps between those particles. This is different than the ’148 Patent, in which the walls are formed of binder and the “pores” are the space inside the binder boundaries, which include at least a part of the inorganic particles.

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

120. Dr. Gido opines that Murakami discloses or renders obvious the claimed ranges because of (1) the general disclosure that “D10 is 0.005 um to 0.4 um, D50 is 0.01 um to 1.0 um, and D90 is 0.5 um to 5.0 um,” where “particle diameter [is] obtained based on volume;” (2) Example 1’s disclosure that “[a]s a filler, α -alumina (D10: 0.22 um, D50: 0.44 um, D90: 1.03 um) was used;” and (3) Example 2’s disclosure that α -alumina (D10: 0.26 um, D50: 0.66 um, D90: 1.53 um) was used as a filler.” Ex. 1003 ¶ 77. I disagree.

121. As explained above in Paragraphs 75-80, and as Dr. Gido recognized in his deposition, the plain and ordinary meaning of the Dv10, Dv50, and Dv90 limitations require the values to be met by the inorganic particles that are in the finished porous film. The ’148 Patent further teaches that these Dv10, Dv50, and Dv90 limitations are critical to the claimed invention. For example, the patent states

that “if the particle sizes of the inorganic particles are too small and are beyond this range, the exchange between the non-solvent (third solvent) in the coagulation solution and the organic solvent (first solvent) in the coating solution will be adversely affected, and it is difficult to form a pore with a large average pore size.” Ex. 1001 at 4:40-45. Conversely, “[i]f the particle sizes of the inorganic particles are too large and are beyond this range, the surface of the formed porous film is not uniform, the strength of the porous film is decreased, and the adhesion force of the porous film is decreased.” *Id.* at 4:45-49. Thus, the ’148 Patent is concerned with the particle sizes in the finished porous film at least because if the Dv10, Dv50, and Dv90 values of the inorganic particles in the finished porous film are not within the claimed range, the surface and properties of that “formed porous film” are adversely affected. *Id.*

122. Dr. Guido and I agree that the D10, D50, and D90 values reported in Murakami are the sizes of the inorganic particle ***starting material*** used to create Murakami’s porous layer. Ex. 2033 at 172:15-173:10. Based on the high-pressure dispersion process used in Murakami to create the porous layer, a POSITA would have understood that the starting values reported in Murakami would not accurately reflect the size distributions of the inorganic particles in the finished porous film. Instead, a POSITA would have expected the inorganic particles in Murakami’s porous layer to have significantly altered sizes and size distribution.

123. As I explained in my Preliminary Declaration, “[a] POSITA reading Murakami would not be able to assume the reported particle sizes of inorganic filler used prior to finalizing the material represent the final particle sizes (and particle size distribution) of the inorganic particles when they are part of the porous layer as is required by the claims.” Ex. 2015 ¶ 104. Instead, as I explained, “[a] POSITA would expect there to be a wide discrepancy between initial particle sizes used and corresponding final sizes in the porous layer because of the method Murakami uses to make the coating layer: high pressure dispersion.” Ex. 2015 ¶ 105 (citing Ex. 1005 ¶ [0141]).

124. Also in my Preliminary Declaration, I cited the brochure for the Sugino Machine Ltd. Star Burst, the same machine used in Murakami, in support of my opinion that the high-pressure dispersion process in Murakami would significantly alter the particle sizes in Murakami’s porous layer (as compared to the starting material). I understand the Board gave little weight to this evidence because (1) “Patent Owner’s arguments are difficult to reconcile with the express disclosure of Murakami,” and (2) the Board is “not persuaded that the distribution change shown in the Star Burst brochure reflects what would occur in the manufacturing process disclosed in Murakami.” Paper No. 10 at 22.

125. Respectfully, I disagree on both points.

126. *First*, the fact that Murakami elsewhere discusses alternative ways to control an average particle diameter and explains the importance of its reported particle-size distribution does not negate Murakami's express disclosures that (1) Murakami uses a high-pressure dispersion process to create the "coating liquid" used to form the porous layer, and (2) this process involves three passes through the "SUGINO MACHINE LIMITED; Star Burst" instrument at 100 MPa. Ex. 1005 ¶ [0141]. It is not disputed that the distribution of α -alumina particle sizes reflects their size distribution *before* the manufacturing steps. Ex. 2033 at 172:15-173:10. As Dr. Guido explained, a POSITA would understand that the starting distribution of sizes used in Examples 1 and 2 likely reflects a commercially available distribution of α -alumina. *Id.* The parties only dispute whether the high-pressure dispersion process used by Murakami would affect the size distribution.

127. Murakami explicitly recognizes that "[t]he coating liquid can be prepared by any method, provided that conditions (such as a resin solid content (resin concentration) and a filler amount) necessary for obtaining an intended porous layer are satisfied." Ex. 1005 ¶ [0073]. Notably, in contrast to resin concentration and filler amount, Murakami does *not* require controlling or maintaining particle size or size distribution during the method for preparing the coating liquid. Instead, one of the ways Murakami recommends preparing the coating liquid is "a high-pressure dispersion method." *Id.* In the examples that Dr. Guido relies on as the examples in

Murakami a POSITA would have been motivated to use (Examples 1 and 2), Murakami discloses using this “high-pressure dispersion method,” applying three passes at 100 MPa of pressure (which is roughly *1000 times* atmospheric pressure). Ex. 1005 ¶ [0141]; Ex. 2033 (Gido Depo Tr.) at 154:19-155:13. If Dr. Gido is correct that these examples are the best examples in Murakami, then a POSITA would have recognized that Murakami teaches using high-pressure dispersion as the *best* method for forming the coating layer. Dr. Gido admits that if particles hit each other at these speeds and pressure, the size distribution would be affected. Ex. 2033 at 155:10-156:20. Dr. Gido further testified that, with respect to high pressure dispersion at 100 MPa, “I really don't know what that's going to do to a particle.” Ex. 2033 at 156:7-8. Dr. Gido admitted that if the 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, but I – I really have no idea what that high pressure does just shooting a single nozzle out into space.” Ex. 2033 at 156:13-20.

128. It was very well-known that a high-pressure dispersion method would significantly alter particle sizes and particle size distribution by applying extreme forces to the inorganic particles. *See, e.g.*, Ex. 2047 (U.S. Pat. No. 10,774,229 B2) at 12:53-67 (explaining that the effect of “high-pressure dispersion” between 20 MPa and preferably not more than 200 MPa reduces particle size and enhances dispersion treatment efficiency); Ex. 2048 (U.S. Pat. No. 10,793,748) at 8:58-9:24

(“These high-pressure dispersers can perform particle refinement by means of the strong shearing force produced in a flow channel when a substance to be treated is sucked in and passed through a narrow flow channel at high pressure, the impact force of collisions that occur between a fluid and the walls of the channel or within the fluid itself due to the design of the flow channel, and the cavitation caused when the fluid is expelled from the fine flow channel and the like.”). Particle size distributions of alumina reported as Dv90, Dv50, and Dv10, as measured using laser diffraction methods, will include sizes of larger agglomerated particles that would certainly break apart into smaller particles at such high pressures as 100 MPa. Given the depth of knowledge about the effects of high-pressure dispersion, including the explicit disclosures in the brochure for the exact instrument used in Murakami (Ex. 2029), the authors of Murakami surely would have understood that high-pressure dispersion would alter the particle sizes in the finished porous layer. Further, the reason to perform *multiple passes* at 100 MPa, as Murakami does, is to ensure greater breakup of the particle sizes, which results in more uniform particle sizes (that is, a narrower particle size distribution). Murakami teaches that its most preferred difference between D90 and D10 is less than 1 micron. Ex. 1005 ¶ [0066]. But the difference between the starting sizes of Murakami’s alumina particle size distribution in its Example 2 is greater than 1 micron. Ex. 1005 ¶ [0161]. Applying 3 passes of high-pressure (100 MPa) would necessarily fracture some of the particles and break

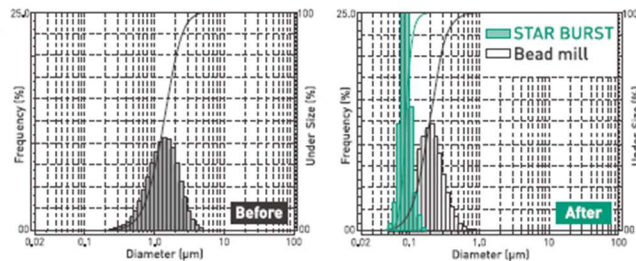
up larger agglomerated particles (and indeed, the larger the particles, the greater the chance of a collision with another particle or wall), which would reduce the sizes of the particles (particularly at the higher particle sizes) and would bring the initial size distribution down to a smaller range, likely within Murakami's most preferred size range (with the difference between Dv90 and Dv10 being less than 1 micron). *See* Ex. 2033 (Gido Depo. Tr.) at 166:2-167:13 (admitting that the ***dispersion*** function of the Sugino Star Burst would break up particles that "are kind of stuck together in little clumps"). Notably, Murakami does not caution anywhere that the difference between Dv90 and Dv10 should not be too low. Ex. 2033 (Gido Depo. Tr.) at 178:19-179:15 ("Q: Does Murakami say anywhere that the difference between D10 and D90 should not be too low? A: They don't say that.").

129. A POSITA would not have assumed that altering particle sizes and size distribution by using high-pressure dispersion was necessarily a mistake by the Murakami authors, but rather that this was by design. Murakami has a different goal than the '148 Patent. It states that its purpose is to decrease variability in voidage (to improve capacity retention). *E.g.*, Ex. 1005 at [0013]. In other words, the design choices in the Murakami reference are in support of making the voids as consistent as possible throughout the entire porous layer. Because the voids in Murakami are the gaps between inorganic particles, a POSITA would understand that Murakami would want to have a narrower size distribution of inorganic particles. This is an

example of the general and well-understood physical and statistical principle that variations in a process input can propagate to the process output, with the level of sensitivity being a matter of experimental determination. Specifically in this case, a POSITA would gather from Murakami that a broader range of particle sizes would lead to increased inconsistency in gap size between particles, while having a narrow range of particle sizes (that is, having more of the particles be identically or near-identically sized) would increase the consistency of gap sizes between those particles. Narrowing the distribution peak is a key point of using high-pressure dispersion, and so it is no surprise that Murakami uses this technique to decrease variability in voidage. Ex. 2029 at 3.

Homogenized Particle Size

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



130. That Murakami purposely uses the Star Burst high-dispersion technique to narrow the size distribution of the filler in its porous layer is also consistent with Murakami’s focus on the difference between D90 and D10 being less than 2.5 microns, more preferably less than 2 microns, more preferably less than 1.5 microns, and “particularly preferably” 1 micron or less. Ex. 1005 at [0066]. A POSITA would have understood that the point of focusing on the “difference” between D90 and D10

values (instead of, for example, the ratio), is that a smaller difference means a narrower distribution. Because Murakami was aiming to have decreased variability in voidage, and thus a narrower distribution in particle size, it makes sense that Murakami would use a high-pressure dispersion technique to achieve a final size distribution that is narrower than its starting material sizes. Thus, it makes sense that Examples 1 and 2 of Murakami, which use the high-pressure dispersion process, are the examples Petitioner and Dr. Guido argue have “superior results.”

131. Moreover, Murakami’s emphasis on pore uniformity and strict quality control would necessarily lead to a deemphasis of other design objectives. Murakami’s express disclosures that a POSITA should use high-pressure dispersion in making the coating layer (necessarily altering particle sizes and size distribution in the *finished* porous layer) are compatible with its express disclosures about the importance of the *starting* sizes and distribution. These express teachings in Murakami are reconcilable when one considers that it was simply easier for Murakami to provide starting sizes and a specific procedure than it was for Murakami to provide the resulting sizes in the finished porous film. By providing the starting sizes and the procedure, a POSITA could more easily reproduce Murakami’s results by starting with the same materials and applying the same procedure, including using the high-pressure dispersion technique. The POSITA would know, like the authors of Murakami, that the actual particle sizes and

distribution in the finished porous film would not match the starting sizes, but they would arrive at the same final particle sizes used in Murakami simply by using the same high-pressure dispersion procedure. This practice of reporting starting values for the particles is not uncommon. Moreover, it was not uncommon for later manufacturing steps to alter particle sizes and distributions. *See, e.g.*, Ex. 1011 ¶[0048] (recognizing that “[i]n general, the D10, D50, and D90 of the non-conductive particles before the porous membrane slurry is prepared are different from those of the non-conductive particles contained in the porous membrane slurry.”); Ex. 2033 at 170:3-171:18 (agreeing “there are methods of manufacture that do alter the distribution of those particle sizes,” such as “ball milling”).

132. By way of analogy, the author of a recipe for a smoothie may very well instruct the user how to safely to cut a frozen banana into 2-inch pieces before putting it into the blender, but that does not mean that the finished smoothie will have 2-inch pieces of banana (or that a chunky smoothie was the author’s intention) if the recipe further instructs the user to hit “blend” at high power for 2 minutes. By the same token, Murakami is telling a POSITA to use a starting material with a specific starting size, even though Murakami and the POSITA know that the resulting final sizes will be different after the entire procedure is followed.

133. Dr. Guido and I agree that the reported D10, D50, and D90 values in Examples 1 and 2 of Murakami reflect the *starting* sizes of those particles before

going through the manufacturing process of Layer B—we differ only in that he assumes (without evidence) that there would be no change to those particle sizes as a result of Murakami’s manufacturing process. Ex. 2033 at 172:15-173:10 (“Q And then in paragraph 140 talking about Layer B, you have a filler that has a certain size distribution, correct? A Yes. Q Okay. *And that size distribution is before any of the other steps that happen in 141, correct?* A It doesn't say that explicitly although it -- you know, it's listed above so you can -- you know, you can read into that as you would. *You know, my -- you know, my guess and my supposition and what a POSITA would probably assume is that, you know, regardless of all this ambitious talk about ball mills and stuff, they just bought this stuff.* You can buy this and it -- they tell you it comes with this analysis of what the particle size distributions are and *they just bought it and they mixed it in.*”) (emphasis added). A POSITA would have understood these reported values to be the particle size distributions of the starting material (i.e. *before* high-pressure dispersion) because that is how the values are reported in Murakami. In Example 1, for instance, Murakami provides the particle size distribution values in parentheses after introducing the type of filler. Ex. 1005 at [0140] (“As a filler, α -alumina (D10: 0.22 μm , D50: 0.44 μm , D90: 1.03 μm) was used.”). Then, in the next paragraph, it explains how “the above α -alumina, CMC, and a solvent” were mixed at a specified ratio to obtain an “alumina dispersion.” *Id.* at [0141]. Murakami then explains that “[t]he obtained [alumina]

dispersion was dispersed by high pressure with the use of a high-pressure dispersing device (manufactured by SUGINO MACHINE LIMITED; Star Burst) (high-pressure dispersion condition; 100 MPa×3-pass), and thus a coating liquid 1 was prepared.” *Id.* It is that “coating liquid 1,” which was created using three passes of high-pressure dispersion at 100 MPa of pressure, that is applied to the porous substrate in Murakami, and then dried to form the porous layer. *Id.* at [0143]. Based on the fact that the particle size is reported at the beginning—next to the starting material (α -alumina), ***before*** it is mixed with anything else and ***before*** high pressure dispersion with the Star Burst—it would be clear to a POSITA that the reported values only reflect the size distribution of the starting material. As I explained above, a POSITA would have expected the particle size distribution to be significantly altered (both narrowed and lowered) after high-pressure dispersion with the Star Burst.

134. ***Second***, while the distribution change shown in the Star Burst brochure (showing the significant impact of 10 passes at 98 MPa of pressure on the average size of alumina particles) may not quantitatively reflect what would occur in the manufacturing process disclosed in Murakami, it does at least provide a useful baseline to roughly estimate what would happen in Murakami and demonstrates that, while testing would be needed to determine the degree of impact, the particle size distribution is certain to be materially altered by using the Star Burst machine at 100

MPa of pressure. The Sugino Machine Ltd. Star Burst is an automated instrument that a POSITA would use for high-pressure dispersion. As with any automated instrument, a POSITA would have understood that the brochure shows representative examples of what happens to particle size and distribution under the default settings for the instrument, unless explicitly stated otherwise. One “application example” in the brochure that I cited in my Preliminary Declaration specifies three variables: (1) number of passes equals 10, (2) pressure equals 98 MPa, and (3) the starting material is alumina with a median diameter of 20 μm . Ex. 2029 at 3. With these three variables, the result of using the Sugino Machine Ltd. Star Burst high-pressure dispersion instrument was that the 20 μm alumina particles were reduced to 0.2 μm . *Id.* This is a one-hundred-fold reduction in size after making 10 passes at a pressure even lower than the pressure used by Murakami.

135. While a POSITA could not use this example to determine the final particle sizes in Murakami with certainty, a POSITA could (and would) have applied the general concepts made clear by this example to the facts of Murakami. In Murakami, the three variables are (1) number of passes equals 3, (2) pressure equals

100 MPa, and (3) the starting material is α -alumina⁸ with D10: 0.22 μm , D50: 0.44 μm , D90: 1.03 μm .⁹ A POSITA would have recognized that the second variable, pressure, is very similar in Murakami to the Sugino brochure (though Murakami is slightly higher, which, if anything, would cause more fracturing and de-agglomeration). The 2% difference in pressure would not have a significant impact for these purposes. Similarly, a POSITA would have recognized that the type of starting material (alumina) is the same in both Murakami and the brochure.

136. Although the starting sizes of the material and number of passes are different in Murakami than in the Sugino brochure, a POSITA would have understood that three passes at this high pressure would still have a significant effect

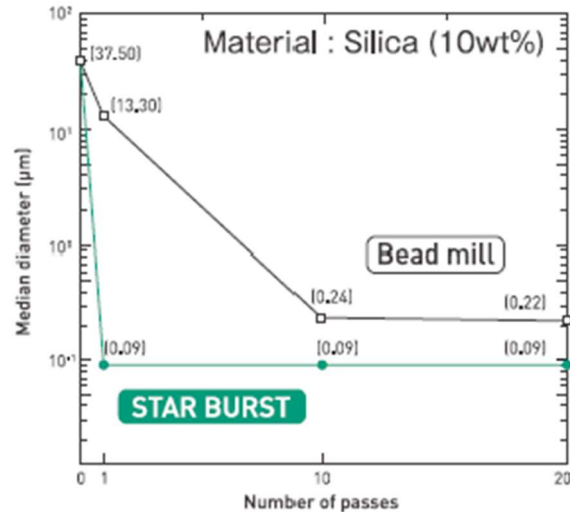
⁸ Alpha alumina is the most stable crystal structure of alumina and so would be the default expectation as it is the most common structure. A POSITA would therefore expect the “alumina” in the Sugino brochure to be referring to “ α -alumina,” as there is no indication that special efforts were undertaken to make a different crystal structure (e.g. beta, gamma, theta, kappa).

⁹ These are the starting values for Example 1. Ex. 1005 at [0140]. For Example 2, the starting values are D10: 0.26 μm , D50: 0.66 μm , D90: 1.53 μm . *Id.* at [0161]. For Murakami’s general disclosure, the starting values are D10: 0.005 to 0.4 μm , D50: 0.01 to 1.0 μm , D90: 0.5 to 5.0 μm . *Id.* at [0018].

on particle size and distribution in Murakami, even though it would not have the same exact effect as ten passes at a slightly lower pressure. As to size, there is a different example in the Sugino brochure that provides an example of distribution narrowing where the starting size average diameter is closer to 1 μm (which is more akin to the smaller starting particle sizes in Murakami). *Id.* at 3.¹⁰

137. A POSITA would have recognized that each additional pass through the instrument yields diminishing returns in affecting particle size. The first pass of a high-pressure dispersion instrument often does most of the work in reducing the particle sizes, pulverizing the initial material to make it much smaller. The later passes of material through the instrument are for catching the fewer and fewer outlier particles that were not pulverized in the initial pass. This phenomenon is illustrated in the Sugino brochure (here, for silica), as shown below.

¹⁰ I also understand that the Board took issue with the fact that one of the examples in the brochure states that “[u]niform particle with narrow particle size distribution can be achieved by controlling the injection speed of raw material,” but injection speed is not specified in Murakami. Paper No. 10 at 22. However, a POSITA would have understood this to mean that one of the benefits of the Sugino Star Burst machine is that the instrument automates (and thus controls) injection speed of raw material.



Also note that the Sugino data show comparative results for material being passed through a bead mill, with qualitatively similar effect, as the bead mill operates by a similar principle of colliding the particles with other particles and surfaces in order to break up aggregates and reduce particle size.

138. Furthermore, this phenomenon of an initially rapid but diminishing effect of powder grinding or milling is also illustrated in Fig.1 and Fig. 3 of Ex. 2041 (Liu) shown below. In this case a mix of particle sizes is ball-milled for increasing amounts of time, equivalent in effect to multiple passes through the Star Burst machine. As shown in Fig. 1, the greatest change to the particle size distribution happens in the first 60 minutes with a much smaller change in the subsequent 60 minutes. As shown in Fig. 3, the largest particle sizes experience rapid decrease in

amount during initial grinding time, while smaller particles experience less rapid decrease in amount during initial grinding time.

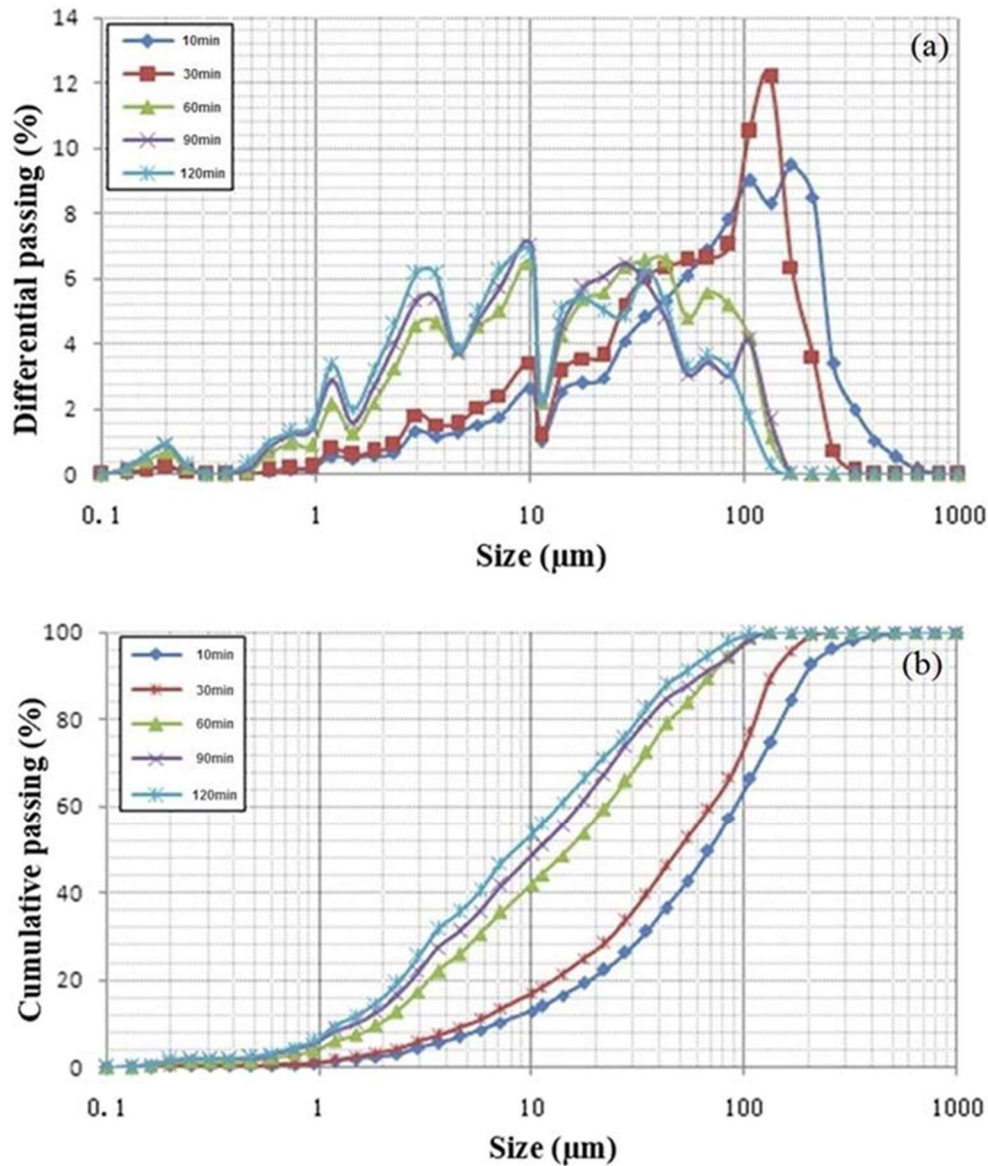


Fig. 1. Particle size distribution curves of glass powder: (a) differential curve, (b) integral curve.

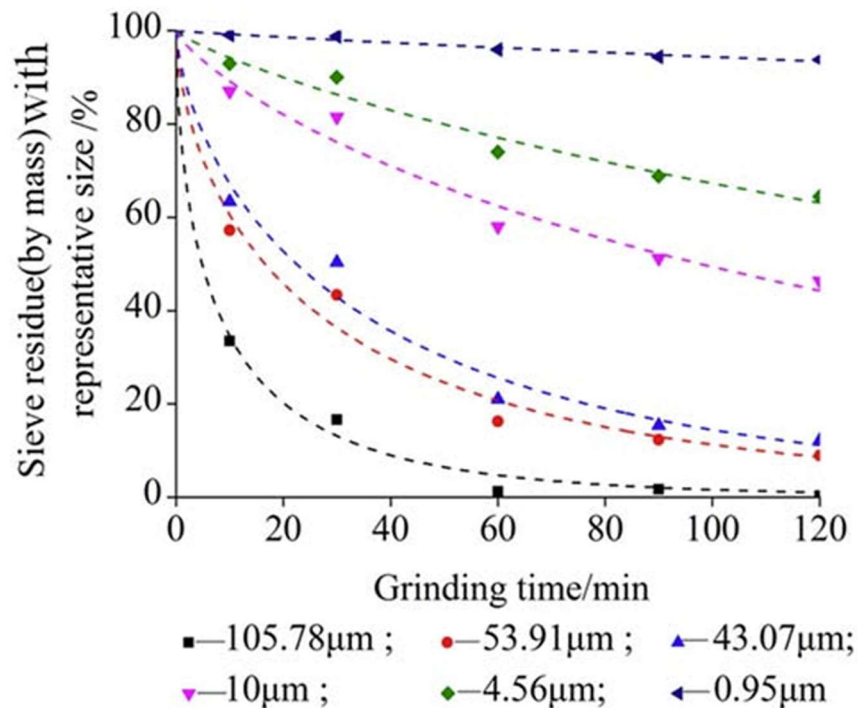


Fig. 3. Fitting curves for relationships between particle sieve residues (by mass) with six representative sizes and grinding time.

139. Again, while the above Star Burst example was for a different material (silica), a POSITA would have understood that this general principle is applicable to other materials that Sugino recommends using the Star Burst for, including alumina. Moreover, the general concepts that (1) using a high-pressure dispersion or other milling techniques significantly alters particle size and size distribution, and (2) the biggest effect on particle size is effectuated with the first high-pressure pass, are supported by other references considering the effects of high-pressure dispersion as of the priority date of the '148 Patent. *See, e.g.*, Exs. 2047, 2048, and 2041; *see also, e.g.*, Ex. 2053.

140. In sum, my point is not that a POSITA would use the Sugino brochure to quantitatively arrive at the particle sizes and size distribution that are present in the finished porous film of Murakami. Rather, a POSITA would use the Sugino brochure (and other general knowledge from that time) to conclude that the particle sizes and size distribution in the finished porous film of Murakami would necessarily be both smaller and narrower (respectively) than the particle sizes and size distribution of the starting material used in Murakami.

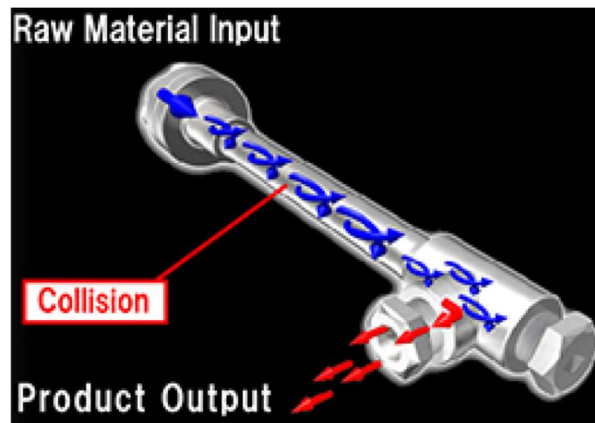
141. I understand that Dr. Guido testified at his deposition that a POSITA would not have thought the high-pressure dispersion method used in Murakami significantly altered particle sizes and particle size distribution—not because a POSITA would not have found the Sugino brochure to be instructive—but because the Sugino brochure indicates that there are multiple chambers for the Sugino Star Burst instrument, and a POSITA would have assumed that Murakami used the single nozzle chamber because they would want to avoid pulverizing the particles. Ex. 2033 at 158:4-14, 159:15-161:7. According to Dr. Guido, use of the single nozzle chamber would only result in *dispersion* of the alumina particles in Murakami (not pulverization) because that chamber focuses on dispersion and exfoliation, rather than pulverization (and alumina cannot be exfoliated). *Id.* at 158:4-161:7.

142. I disagree with Dr. Guido that a POSITA would have assumed Murakami used the single nozzle chamber of the Sugino Star Burst instrument, rather than one

of the other four chambers—all of which also are designed for dispersion. Ex. 2029 at 4; Ex. 2033 at 158:15-18. If anything, a POSITA would conclude that Murakami used the “oblique collision type chamber.” This is at least because (1) a POSITA would conclude Murakami used the standard chamber unless specified otherwise, and Sugino’s website (which Dr. Guido suggested a POSITA would view, Ex. 2033 at 166:19-167:13) states that the oblique-type collision chamber “is the standard-type collision chamber, which achieves minimum contamination.” Ex. 2044 at 1. This is also because (2) the oblique collision type chamber is the chamber that the brochure lists as effective for “highly abrasive materials.” Ex. 2029 at 4. According to the Sugino brochure, alumina (which is the type of inorganic particle used in Examples 1 and 2 of Murakami) is one of these “abrasive materials.” *Id.* at 3. A POSITA would not have assumed that Murakami used the single nozzle chamber because the Sugino brochure states that the single nozzle chamber is effective for “high ratio materials such as graphite, mica, and montmorillonite.” *Id.* at 4. A POSITA would have no reason to believe that Murakami would have used the single nozzle chamber, which is designed for high aspect ratio materials such as graphite, over the oblique collision type chamber, which is explicitly called the “standard-type” chamber by Sugino and is specifically designed for abrasive materials like alumina.

143. Even if Murakami had used the single nozzle chamber, however, I disagree with Dr. Gido's statistically flawed conclusion that such use would not have any meaningful effect on particle sizes and particle size distribution. First, the Sugino website specifies that the single nozzle chamber of the Sugino Star Burst instrument *also* pulverizes when it is used with raw materials, which a POSITA would have understood to include a typical particle like alumina. Ex. 2044 at 2 ("Raw materials are pulverized and dispersed with a cavitation effect generated by the injection of pressurized raw material slurry."). A POSITA would have understood that it is when this chamber is used with "*layered*" materials, such as mica or bentonite or graphite, that it is "cleaved," or as the brochure puts it, "exfoliated." Ex. 2029 at 4. As Dr. Gido explained during his deposition, alumina particles are not "exfoliated" because they are not layered materials. Ex. 2033 at 158:19-159:14. But as the Sugino website confirms, this does not mean that the single nozzle chamber would not pulverize a raw material like alumina if alumina were used in that chamber—to the contrary, it does pulverize raw materials. Ex. 2044 at 2. This graphic in the brochure (Ex. 2029) simply indicates that the single nozzle chamber is designed for use with layered materials, and the scientific term for when layered materials are broken up into smaller pieces is not "pulverization" (like it is for a material like alumina) but rather "exfoliation" or "cleaving." Further, Dr. Gido's statement during the deposition that particle collisions are the source of the

dispersion and pulverization, “but I – I really have no idea what that high pressure does just shooting a single nozzle out into space” shows a fundamental misunderstanding of the geometry of Sugino’s Star Burst single nozzle chamber. Ex. 2033 at 156:13-20; *see also* discussion *supra* at Paragraph 127. As shown in Ex. 2044 and reproduced below, the material passing through the single nozzle chamber is enclosed in a pipe, not “shooting a single nozzle out into space.” The single nozzle chamber contains multiple baffles that force the fluid stream to split and recombine, causing particles to collide at multiple points in the path.



144. Second, Murakami states that it used the Sugino Star Burst instrument at a pressure of 100 MPa for three passes. Ex. 1005 ¶ [0141]. As Dr. Gido admits, 100 MPa is an enormous amount of pressure (roughly 1,000 times atmospheric pressure). Ex. 2033 at 154:19-155:13. The idea that alumina particles and the entraining liquid could be subjected to this extreme pressure differential and the particles not collide with each other or the walls of the chamber and at least partially

break apart over the course of three passes through the instrument is virtually impossible. Furthermore, Murakami's use of three passes, rather than just one, implies a concerted effort to ensure that significant energy is imparted to the particles, rather than a gentle or modest level of dispersion. Indeed, even Dr. Gido asserts that Murakami's goal in using high-pressure dispersion as a second step after the first alumina dispersion is obtained in Murakami is to "break [alumina particle clumps] up into their individual particles." Ex. 2033 at 166:2-167:13. The idea that Murakami could and would use high-pressure dispersion to break up alumina clumps into their individual particles, without also having any effect on the particle sizes of those individual alumina particles themselves, is non-sensical. Moreover, breaking up agglomerated particles into individual particles alone, without fracturing the individual particles, would significantly alter the Dv10, Dv50, and Dv90 values because the starting values necessarily included agglomerated particle sizes. Thus, even if it was not Murakami's intention to pulverize the alumina particles by using Sugino's high-pressure dispersion Star Burst instrument, a POSITA would have understood that the particle sizes and particle size distribution were necessarily altered through this process.

145. For at least these reasons, it is my opinion that Murakami does not disclose, suggest, or otherwise render obvious "wherein the inorganic particles have

particle sizes that Dv10 is in a range of 0.015 μm to 3 μm , Dv50 is in a range of 0.2 μm to 5 μm , and Dv90 is in a range of 1 μm to 10 μm .”

4. Murakami Does Not Disclose or Render Obvious the “Ratio of Dv90 to Dv10”

146. Dr. Gido opines that Murakami discloses “the inorganic particles have particle sizes that the ratio of Dv90 to Dv10 is in a range of 2 to 100.” I disagree at least because the D90 and D10 values reported by Murakami do not reflect the Dv90 and Dv10 values of the particles in Murakami’s finished porous layer.

147. Moreover, as I described above, both Dv90 and Dv10 of the particles in the finished porous layer will necessarily be smaller than the initial size distribution before completing the manufacturing process. Because the degree to which they will each be smaller is unknown (though I believe it is likely that Dv90 will decrease more than Dv10 on an absolute basis, because larger particles are more likely to experience collisions, and therefore the ratio of Dv90/Dv10 is likely to be smaller in the finished product than the ratio for the starting particle sizes), the ratio between Dv90 and Dv10 in the finished particles cannot be determined with any reliability from Murakami’s disclosure and may well be less than 2. Because the possibilities include values that are less than 2, which would be outside of the claimed ratio, it is my opinion that the Petition fails to demonstrate that Murakami includes or renders obvious this claim element.

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

148. It is my understanding that in Ground 2, Petitioner asserts and Dr. Gido opines that Murakami and Honda render obvious Claims 3 and 12. Pet. at 41-42; Ex. 1003 ¶¶ 140-47. These claims recite:

3. The porous film according to claim 1, wherein the average wall thickness between the pores is in a range of 20 nm to 500 nm.

12. The lithium-ion battery according to claim 10, wherein the average wall thickness between the pores is in a range of 20 nm to 500 nm.

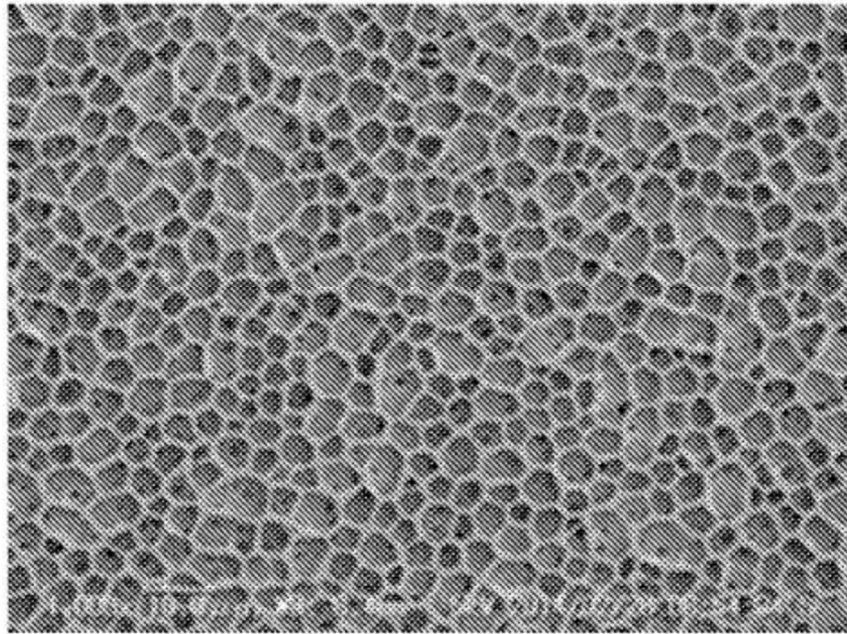
149. These claims are not obvious for the same reasons noted above with respect to Independent Claims 1 and 10. Petitioner does not rely on Honda to address any of the limitations that are missing from Murakami in the independent claims 1 and 10 I have addressed above.

150. Claims 3 and 12 are not obvious for the additional reason that a POSITA would not have been motivated to combine Honda with Murakami with a reasonable expectation of success.

151. ***First***, a POSITA would not be motivated to combine Honda and Murakami because the two references rely on fundamentally incompatible pore structures. In Murakami, as explained in Paragraphs 88-100, the pores are simply gaps between inorganic particles. To the extent one could say Murakami has pore

walls, they would simply be the inorganic particles themselves. In contrast, Honda discloses a honeycomb structure with “a partition wall in which a porous layer is partitioned into a large number of cells.” Ex. 1007 at [0045]. This “partition wall” in Honda appears based on the SEM images in Honda to be made of polyvinylidene fluoride resin.

[FIG. 1]



152. This is apparent based on the smoothness of the walls in the SEM image. A POSITA would have understood that, for the pore walls in Honda to be so smooth and contained, they would need to be made of a smooth material, like a resin. This is also evident based on the fact that Example 1, of which Figure 1 is an SEM image, does not use any inorganic particles. Ex. 1007 at [0118]; Ex. 2033 at 255:20-256:19.

153. A POSITA would recognize that Honda's disclosures about partition or pore wall thickness would only work for a pore structure where the pore walls are made of resin or other smooth material, not one like Murakami's, where there are not smooth "pore walls" but rather just gaps between hard inorganic filler particles. To achieve the "pore wall" thickness disclosed in Honda but retain the rest of Murakami's pore structure (which Petitioner and Dr. Guido rely on for this Ground), a POSITA would have to (at the very least) reduce the inorganic particles to the sizes of Honda's pore walls. Doing so would completely change the particle size distribution of Murakami, and a POSITA would not be able to modify the particle sizes of Murakami to fit within the 0.1 μm to 2 μm thick pore walls of Honda without taking the particle sizes and particle size distribution outside of the claimed ranges (Dv10: 0.015 to 3 μm , Dv50: 0.2 to 5 μm , and Dv90: 1 to 10 μm). More than that, however, Claims 3 and 12 require an average pore wall thickness of 20 nm to 500 nm (0.02 μm to 0.5 μm). So for the combination of Murakami and Honda to meet these claims, it would not be enough to fit Murakami's particle sizes into a pore wall of 0.1 μm to 2 μm (the thicknesses disclosed in Honda) but rather would require fitting Murakami's particle sizes into a pore wall of 0.1 μm to 0.5 μm (the lowest thickness disclosed in Honda to the maximum thickness allowed by the claims). It is impossible to reduce the size of the inorganic particles to between 0.1 μm to 0.5 μm and still fall within the claimed particle size ranges of the claims because the

biggest inorganic particle (0.5 μm) would be half the size of the minimum required Dv90 value (1 μm), at *most*. Thus, reducing the particle sizes to achieve the claimed wall thicknesses (which is necessary where the pore walls are inorganic particles, like in Murakami) takes this combination well outside the claimed particle sizes.

154. **Second**, a POSITA would not have been motivated to combine Honda with Murakmi because Honda relies on a surfactant in its porous layer to form the honeycomb structure. *See* Ex. 1007 at [0064]. A POSITA would have understood that the surfactant in Honda affects Honda's pore structure and wall thicknesses. Ex. 2033 at 258:2-259:15 (Dr. Guido testifying that the surfactant "is another knob that you can dial in this case to control that pore structure the way you want it, the wall thickness, the pore size and so forth"). The use of a surfactant is central in Honda's formulation and teachings. Indeed, not just any surfactants are used, but those with specific characteristics. For example:

[0064] [Surfactant Having HLB value of 5.0 to 8.0] From the viewpoint of improving the ion permeability of the separator, the porous layer according to the present disclosure preferably contains a surfactant having an HLB value of 5.0 to 8.0, and the surfactant and the polyvinylidene fluoride resin are mixed inside the porous layer. It would follow that the ion permeability of the separator is improved by the surfactant existing and functioning at the interface between the porous layer and the porous base material.

It is no accident that every one of Honda's embodiments uses a surfactant, and the Examples and Comparative examples are distinguished by the type and amount of surfactant.

155. Whether or not to use surfactant, and its particular identity, is a substantive change to a formulation that has far-reaching chemical consequences. A surfactant, like any other chemical, can have advantages and disadvantages in a complex battery environment. Ex. 2033 at 258:2-259:15; *see also* discussion *supra* at Paragraph 36. The surfactant is intended to sit at the interface between two phases, such as between a polymer and a solvent or non-solvent, or between a polymer and a substrate material, and modify the surface interaction. Ex. 2033 at 257:1-258:1. A possible advantage of a surfactant is that it could lead to a pore structure one wants by decreasing interfacial energy and influencing how the solid polymer precipitates and aggregates. A disadvantage of a surfactant is that its addition could destroy the pore structure one expected or wanted.

156. Another disadvantage is that the surfactant will be left behind in the electrode following evaporation of the solvent, and likely would dissolve into the subsequently introduced battery electrolyte and deteriorate or react on electrode surfaces during operation. So, the surfactant disrupts the carefully crafted additive package and chemistry present in the electrolyte. Due to these unexpected and unknown interactions, a POSITA must do careful experiments to validate if yet

another additive (the surfactant) has any benefit that might outweigh its detrimental effects on battery performance. Therefore, a POSITA would not assume that a given surfactant taught by Honda would be advantageous to combine with formulations from another reference, until experimentally proven otherwise. Ex. 2033 at 259:19-260:9 (“Q: Do you have to test a surfactant to know what effect it will have on your pore creation and pore structures? . . . A: “[Y]ou might hypothesize that it is going to tend to make the pores bigger for instance all things being equal, . . . but a POSITA would need to, you know, do some tests, make some sample materials and investigate them to see how that works out, right. *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.*”) (emphasis added).

157. Honda shows in its embodiments that getting to Honda’s desired honeycomb structure is challenging. Even minor modifications to mass ratios of surfactant to polymer binder, or identity of surfactant, can disrupt the delicate balance of interactions needed to get a honeycomb structure.

158. Murakami does not use a surfactant in the examples Dr. Guido relies on. And while Murakami briefly mentions that adding a surfactant is theoretically possible, a POSITA would have needed to do significant experimentation with adding a surfactant to ensure that it would not destroy the desired pore structure in Murakami. Ex. 2033 at 259:19-260:9. Murakami’s formulations are so far removed

from Honda's on this account, that there is no "middle ground" when it comes to the chemistry. Neither Dr. Gido nor Petitioner explains why a POSITA have been motivated to jeopardize the carefully crafted porous structure and performance characteristics achieved in Murakami by adding a surfactant like in Honda.

159. ***Third***, Honda discloses that *if* a filler is used in its porous layer, "the content of the inorganic filler in the porous layer is preferably 1 mass% to 95 mass%, more preferably 5 mass% to 80 mass%, and ***further preferably 10 mass% to 50 mass%***." Ex. 1007 at [0062]. Thus, a POSITA would understand that Honda teaches preferably using a much smaller proportion of filler (e.g. inorganic particles) than Murakami, which encourages using filler that is "most preferably 90 mass % or higher," up to 99 mass % of the layer. Ex. 1005 at [0070]. Given these disparate teachings between Honda and Murakami, a POSITA wanting to use the general filler-dense structure of Murakami and simply take the pore wall thickness of Honda would recognize that doing so is not possible at the much lower mass % of filler preferred by Honda. Conversely, if a POSITA were to use the mass % of Honda and attempt to achieve Honda's structure but with Murakami's inorganic particle sizes, such an approach would be impossible for the reasons discussed below (Reason #6 and No Reasonable Expectation of Success). Thus, a POSITA would recognize that one cannot combine Murakami and Honda to arrive at the claimed invention and would not be motivated to do so.

160. **Fourth**, a POSITA would not have been motivated to combine Honda with Murakami because they have incompatible types of pores and incompatible pore sizes. Honda teaches an “average cell opening diameter” of between 0.1 μm to 10 μm ,” with cell walls made of binder. Ex. 1007 at Claim 2; *see also id.* at Table 1, [0113]. In contrast, Murakami teaches that it is preferable to have a “pore diameter” of 3 μm or less, or even more preferably, 1 μm or less, with pores made from gaps in between inorganic particles. Ex. 1005 at [0037], [0093].¹¹ In light of this disclosure in Murakami, a POSITA would not have been motivated to use Honda’s pore structure and wall thicknesses, which in Honda’s efficacious examples results in pores with diameters of 3.6 to 4.3 μm (compared to the poorly performing Comparative Examples which have diameters of 0.2 μm to 2.5 μm).

161. **Fifth**, a POSITA would not have been motivated use Honda’s pore structure and wall thicknesses because Honda does not guarantee or necessarily promote capacity retention. Honda teaches in its choice of Examples and Comparative Examples (Tables 1-4) that the advantage of the honeycomb structure is how it is associated with improved adhesion to adjacent electrodes and how it

¹¹ For the purposes of assessing motivation to combine Murakami and Honda, a POSITA would have understood the “average cell opening diameter” in Honda to be measuring the equivalent of the “pore diameter” in Murakami.

maintains a high Gurley value. Gurley is a measure of how easily gas can transport through the membrane and could be interpreted as a proxy for how easily ions can transport through the pores.

162. Of note, however, Honda does not teach that advantages of the honeycomb structure include increased capacity retention rate. As shown in Honda Table 2, Comparative Example A3 has superior or equivalent capacity retention to both Examples A1 and A2. Likewise, as shown in Honda Table 4, Comparative Examples B2 and B3 have superior or equivalent capacity retention rates to all of the Examples B1 through B10. Indeed, Examples B9 and B10 have notably worse capacity retention than Comparative Examples B2 and B3. So a POSITA seeking improved capacity retention rate would understand that Honda does not guarantee or necessarily promote capacity retention, and would not be motivated to follow Honda's teachings or attempt to combine Honda with other references if considering capacity retention as important. This is especially true for Murakami, where capacity retention is the core objective. Ex. 1005 at [0010]-[0012].

163. *Sixth*, a POSITA would not have been motivated to combine Murakami with Honda because there is no basis to use Murakami's particle sizes with Honda. While Honda says that use of a filler is possible, the only embodiments in Honda with inorganic filler, or filler of any kind, are Examples B5 and B6 and Comparative Example B3. In each of these three cases the particles are magnesium hydroxide,

specifically commercial product Kisuma 5P made by Kyowa Chemical (see [0128]). A POSITA could know, from review of the product catalog from Kyowa Chemical, that the Kisuma 5P material has average particle size (D50) of 0.72 μm and no particles larger than 5 μm (see product catalog at Ex. 2046). However, there is no information provided in Honda or even by the particle manufacturer to demonstrate that the size conditions in paragraph [0059] were satisfied by any of the Examples. Furthermore, Honda's embodiments only incorporate one particle size, offering to a POSITA no teaching of criticality or scientific evidence that particle size matters for battery function under Honda's material formulations. Thus, a POSITA could not with adequate confidence make predictions about how Honda's formulations would combine with Murakami's particle sizes and formulations, leading to undue experimentation being required to combine these references.

164. ***Finally***, even if a POSITA were to combine Honda with Murakami, they would not have a reasonable expectation of success at arriving at the claimed invention. As briefly mentioned above, because the pore walls in Murakami are the inorganic particles themselves, applying Honda to Murakami's existing structure would mean adjusting the inorganic particle sizes to be not greater than the wall thicknesses disclosed in Honda that would meet the claimed thickness of Claims 3 and 12 (0.1 to 0.5 μm). *Compare* Ex. 1007 at [0045] (disclosing wall thicknesses between 0.1 and 2 μm) *with* Claims 3, 12 (requiring wall thicknesses between 0.02

μm and 0.5 μm). This would mean altering the particle size distributions disclosed in Murakami, such that the inorganic particles in the combination would be no greater than 0.5 μm and would no longer meet the particle size distributions required by the claims (at least, for example, Dv90 which is 1 μm to 10 μm). Doing so would also be a very difficult task to achieve, because a POSITA would need to find a way to uniformly distribute the inorganic particles such that they could ensure a consistent thickness between pores of between 0.1 and 0.5 μm. There is no teaching in either Murakami or Honda regarding how to do so.

165. Moreover, even if a POSITA were to attempt to use Honda's porous structure but with Murakami's inorganic particle sizes, they would be unsuccessful because Honda requires different inorganic particle sizes than those required by Murakami, as explained above and made clear in Honda. Ex. 2007 at [0058]-[0059]; *see* discussion *supra* at Paragraph 163. In addition, a POSITA would have understood that the large particle sizes in Murakami could not be effectively held in place by the thin pore walls required by Honda and the claims, but rather would be more likely to fall out of the structure (an outcome Dr. Guido agrees a POSITA would try to avoid). Ex. 2033 at 93:1-94:6. Also as explained above, a POSITA would further recognize that it would be impossible to achieve Honda's perfect honeycomb structure without the use of a surfactant. Neither Dr. Guido nor the Petition suggest

using the surfactant of Honda in their proposed combination, and adding a surfactant to Murakami would significantly change Murakami's pore structure.

166. Thus, the combination of Honda and Murakami does not render claims 3 and 12 obvious for these additional reasons.

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

167. It is my understanding that in Ground 3, Petitioner asserts and Dr. Gido opines that Murakami and Tanaka render obvious Claims 4 and 13. Pet. at 43-48; Ex. 1003 ¶¶ 148-61. These claims recite:

4. The porous film according to claim 1, wherein a pore size distribution coefficient of the pores in the porous film is in a range of 1 to 5.

13. The lithium-ion battery according to claim 10, wherein a pore size distribution coefficient of the pores in the porous film is in a range of 1 to 5.

168. These claims are not obvious for the same reasons noted above with respect to Independent Claims 1 and 10. Petitioner does not rely on Tanaka to address any of the limitations that are missing from Murakami in the independent claims 1 and 10 I have addressed above.

169. Claims 4 and 13 are not obvious under this ground for the additional reason that a POSITA would not have been motivated to combine Tanaka with Murakami with a reasonable expectation of success.

170. Tanaka is not in the same field of the invention and is instead focused primarily on using its porous layer in applications other than batteries. Tanaka is focused on improving water absorption performance through a porous sintered compact. Ex. 1009 at Abstract. As Dr. Gido admits, the main purpose of ensuring high water absorption performance in Tanaka is because “they want to use these things 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. A POSITA looking to improve a lithium-ion battery separator would not look to a reference primarily focused on improving water absorption performance for applications other than in batteries. There is no dispute that there is no water in a lithium-ion battery. Ex. 2033 at 266:18-267:7. There is also no dispute that Tanaka almost exclusively discusses applications other than for use in lithium-ion batteries. *Id.* at 265:14-266:9. The only place in Tanaka Dr. Gido identifies as discussing use in lithium-ion batteries is in Paragraph 69, which includes a laundry list of potential uses for a filter and does not provide any examples of how Tanaka’s filter would work in a lithium-ion battery, let alone how effective it would be. Ex. 1009 ¶ [0069] (“The polyolefin porous sintered compact obtained by the present embodiment can be used as a general industrial member such as an adsorption immobilization transport sheet and the like, and can also be used in the life sciences field such as a support sheet for a rapid test

kit by an immunochromatography method, a filter for apheresis treatment, a filter for artificial dialysis and the like, a pre-filter for various implants, a bioanalysis kit and the like, a carrier for a low-rigidity filter and the like, a carrier for an ion exchange resin and the like, and also in the electronics field such as an ink absorber for a printer head, a carrier for a solid electrolyte, a member for a fuel cell, a separator for a lithium ion secondary cell or a lead storage cell and the like.”). Moreover, there is no disclosure anywhere in Tanaka that suggests that Tanaka’s porous substrate would solve the problem addressed by the ’148 patent, which is eliminating or reducing the gap between the separator and electrodes to improve capacity retention.

171. Achieving Tanaka’s pore size distribution ratio would require altering the pore sizes in Murakami to match Tanaka. The pore sizes in Tanaka’s filter necessarily depend on the polymer and process of formation because there are no inorganic particles in Tanaka. Ex. 2033 at 267:8-16. In contrast, Murakami’s pore sizes are necessarily affected by particle sizes and particle size distribution used in the porous film. Ex. 2033 at 204:3-205:9. It would not be clear to a POSITA that they would be able to achieve Tanaka’s pore sizes while maintaining Murakami’s particle sizes and particle size distributions. Moreover, given the painstaking efforts by Murakami to control pore creation and minimize voidage in its porous film, a POSITA would not be motivated to potentially alter Murakami’s pore structure and features by attempting to achieve Tanaka’s pore sizes and pore size distribution

coefficient, especially not based on a single line in Tanaka about the mere potential to use Tanaka's filter in a lithium-ion battery (with no examples or data as to how it performs in that context). Indeed, even Dr. Gido admitted during his deposition that Tanaka's porous substrate is less useful for use in a lithium-ion battery separator than in Honda, for example, because Honda "actually constructs batteries and you know tests them." Ex. 2033 at 268:17-269:4. In contrast, "Tanaka is mainly focused on more of these sort of filtration type applications." *Id.* Similarly, a POSITA would not be motivated to attempt Tanaka's pore sizes and pore size distribution coefficient at the risk of destroying the carefully balanced design disclosed in Murakami, which actually constructs and tests batteries.

172. A POSITA further would not have been motivated to combine Tanaka with Murakami because Tanaka uses a sintered method, which is different than (and incompatible with) Murakami. As Dr. Gido explained in his deposition, "sintering is taking little particles of something like little grains of something and – bonding them together oftentimes maybe by heating them so that their outer surfaces kind of melt just enough to stick together," or "compressing them even in the absence of heat, so that the outer layers kind of meld or merge into one another and they stick together." Ex. 2033 at 265:5-13. This sintering process in Tanaka is applied to a polyolefin and does not involve any inorganic particles. Ex. 2033 at 266:1-9, 267:8-16. In contrast, as Dr. Gido has repeatedly pointed out, Murakami's "porous layer

consists of nearly all filler material and relatively little resin by weight.” Ex. 1003 ¶ 103. Given these extreme differences in chemical makeup between Tanaka and Murakami, a POSITA would not expect the sintering process of Tanaka’s polyolefin to work with Murakami’s densely-filled inorganic particle layer. Not only this, but the binder in Murakami is designed to hold the inorganic particles together, and so there is no need for sintering to “meld or merge” Murakami’s inorganic particles together.

173. Moreover, even if a POSITA were motivated to combine Tanaka with Murakami, a POSITA would not have reasonably expected to successfully arrive at the claimed invention. First, the Petition and Dr. Gido rely on Tanaka’s disclosure of pore size distribution coefficients in a polyolefin porous *substrate* to disclose the same in a porous *film* (or layer). But the claims require the porous film to have the claimed pore size distribution coefficient—not the porous substrate. A POSITA would not expect to achieve the pore sizes and pore size distribution coefficient of Tanaka’s polyolefin porous substrate in Murakami’s primarily inorganic particle porous film. Second, neither Dr. Gido nor the Petition have explained how a POSITA would be able to accomplish Tanaka’s pore sizes and pore size distribution coefficient while retaining Murakami’s particle sizes and particle distribution, and a POSITA would not expect to be able to. As Dr. Gido admitted in his deposition, 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 is dependent on the relative pore sizes in Tanaka. Thus, a POSITA could not successfully imitate Tanaka’s pore sizes without altering the particle sizes and particle size distribution of Murakami, and neither Dr. Gido nor the Petition explain how or why they would do so.

174. Thus, the combination of Tanaka and Murakami does not render claims 4 and 13 obvious for these additional reasons.

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

175. Petitioner contends that Murakami and Beard render obvious Claims 1, 2, 5-11, and 14-19 of the ’148 Patent.

176. This combination fails to disclose or render obvious the Challenged Claims for at least three reasons. First, as explained above in Paragraphs 120-147 and in my Preliminary Declaration at Paragraphs 104-115, Murakami does not disclose or render obvious the claimed particle size distributions (Dv10, Dv50, or Dv90) or the claimed ratio of Dv90 to Dv10. Neither Dr. Gido nor the Petition rely on Beard to address the particle size limitations, and therefore this ground fails for the same reasons provided with respect to Ground 1.

177. Second, even if Murakami did disclose the claimed particle size distributions and ratio (which it does not), and even if a POSITA would have

combined Murakami with Beard (which they would have not for the reasons discussed below), the combination of Murakami and Beard does not disclose or render obvious all the claimed elements. *See* discussion *infra* in Paragraphs 179-194, below; *see also* Ex. 2015 ¶¶ 124-134.

178. Third, as I explained in Paragraphs 135-149 of my Preliminary Declaration and elaborate on below in Paragraphs 195-217, a POSITA would not have been motivated to combine Beard with Murakami with a reasonable expectation of success.

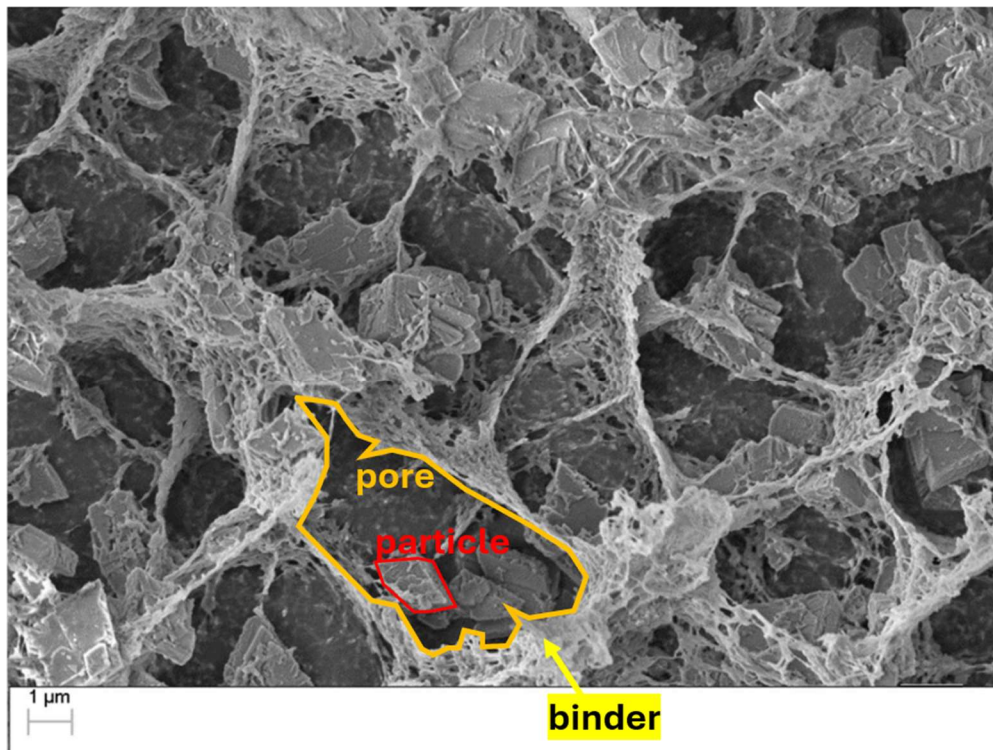
1. Neither Beard Nor Murakami Disclose or Render Obvious Pores that “At Least Comprise[] a Part of the Inorganic Particles”

179. As explained above in Paragraphs 114-119 and in Paragraphs 97-99 of my Preliminary Declaration, Murakami does not disclose pores that “at least comprise a part of the inorganic particles.” Given this deficiency, Dr. Guido tries to rely on Beard’s disclosure for this limitation.

180. In my Preliminary Declaration, I explained that Beard does not disclose or render obvious this limitation, either. Ex. 2015 at ¶¶ 124-134. I incorporate by reference that discussion herein and elaborate on my analysis below.

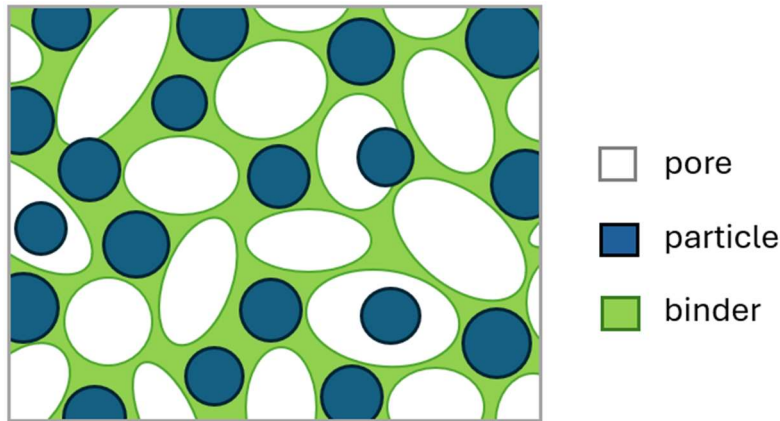
181. As I explained above in Paragraphs 16-27, a porous layer containing binder and inorganic particles may take the form of one of many different pore structures. The Challenged Claims of the ’148 Patent are not satisfied by just any

porous layer having binder and inorganic particles, but rather require a specific type of pore structure where (1) the pores are “formed by the binder” and (2) the pores “at least comprise part of the inorganic particles.” An annotated version of an embodiment presented in the '148 Patent that embodies this pore structure is shown below.



182. Using the same style of illustration discussed in the technical background section, the '148 Patent's pore structure would look like this:¹²

¹² Again, this drawing is meant to be illustrative of the arrangement of particles and binder leading to the pore structure. While no exact in every particular slice, the

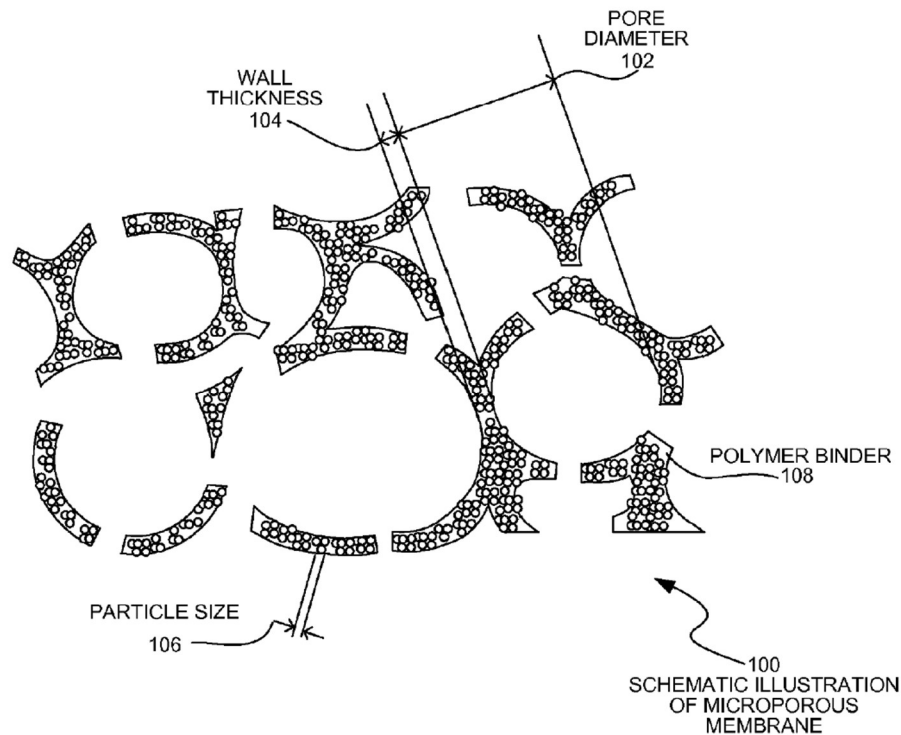


183. Neither Beard nor Murakami disclose a porous layer with this claimed pore structure. As explained in Paragraphs 114-119 above, Murakami does not disclose or render obvious this claimed pore structure because it meets neither requirement: (1) its pores are not formed by the binder, but rather are formed by gaps between inorganic particles, and (2) the pores do not at least comprise part of the inorganic particles because the inorganic particles are the pore walls in Murakami.

184. Beard varies from Murakami in many key ways, including that Beard includes much more binder and uses fewer, much smaller, and more uniformly sized inorganic particles; such that the resulting pore structure in Beard is one in which the pores are the empty spaces between pore walls, and the pore walls are made of

drawing is consistent with Example 3 in the 148 Patent, having around 53% porosity and a volume ratio of 1.2 between the inorganic particles (blue) and the binder components (green).

binder on the outside and packed tightly on the inside with inorganic particles enveloped within the binder itself. This is shown in the conceptual image Fig. 1, of Beard:



185. This pore structure in Beard is different from the pore structure claimed in the '148 Patent because it fails to meet the second pore structure requirement: that the pores at least comprise part of the inorganic particles. Instead, the inorganic particles in Beard are tightly packed *inside* the pore walls; such that it is the binder that delineates the pores, and the inorganic particles do not contact or extend into the pores themselves.

186. In its Institution Decision, I understand that the Board at least preliminarily concluded that Beard's pore structure meets this limitation because "Beard accounts for this limitation in its disclosure in Figure 1 of particles that extend into the pores." Paper No. 10 at 32. Respectfully, I disagree that Figure 1 of Beard discloses or renders obvious inorganic particles extending into the pores.

187. Beard contains a disclaimer concerning Figure 1, disclosing that "FIG. 1 is a schematic diagram of an embodiment 100," but that "[e]mbodiment 100 is *not to scale*," and is instead simply "used to define the various dimensions of a porous membrane." Ex. 1010 at [0017] (emphasis added). A POSITA would have understood that this Figure in Beard is thus designed to give a general idea illustrating how it defines "the various dimensions of a porous membrane."

188. Taking the rest of Beard's disclosure into consideration, in addition to Figure 1, a POSITA would have concluded that the goal of Beard is to limit the inorganic particles' "interference in pore creation." Ex. 1010 ¶ [0086] ("When 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."). In explaining Figure 1, Beard states that "[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] (emphasis added). Beard also

explains that the 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 (emphasis added) Beard further states that the “TiO₂ particles are on the order of or smaller than the cell wall thickness **208**.” *Id.* ¶ [0037]. Beard explains that “[g]ood results may be achieved when the solid particles are contained exclusively or largely within the pore walls.” *Id.* at [0086]. All these disclosures confirm the general point illustrated by Beard’s Figure 1—that the pore walls are made of binder packed tightly with inorganic particles. They further confirm that this tight packing is by intention; Beard teaches that it is preferable to not have inorganic particles extend into the pores because “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].

189. In its Institution Decision, the Board appears to have discounted these written disclosures in Beard by reasoning that language like “may” or “largely within the pore wall” (instead of “exclusively”) indicates that there must be some circumstances in Beard where at least some inorganic particles peek out of the pore walls and into the pores. Paper No. 10 at 34. Respectfully, I disagree.

190. **First**, even if there are a few inorganic particles that seemingly “peek out” of the clean structure formed by the binder (like the red arrows in Petitioner’s

annotated version in Fig. 1, below), a POSITA would understand that these particles in Beard are still individually coated in a thin layer of binder.

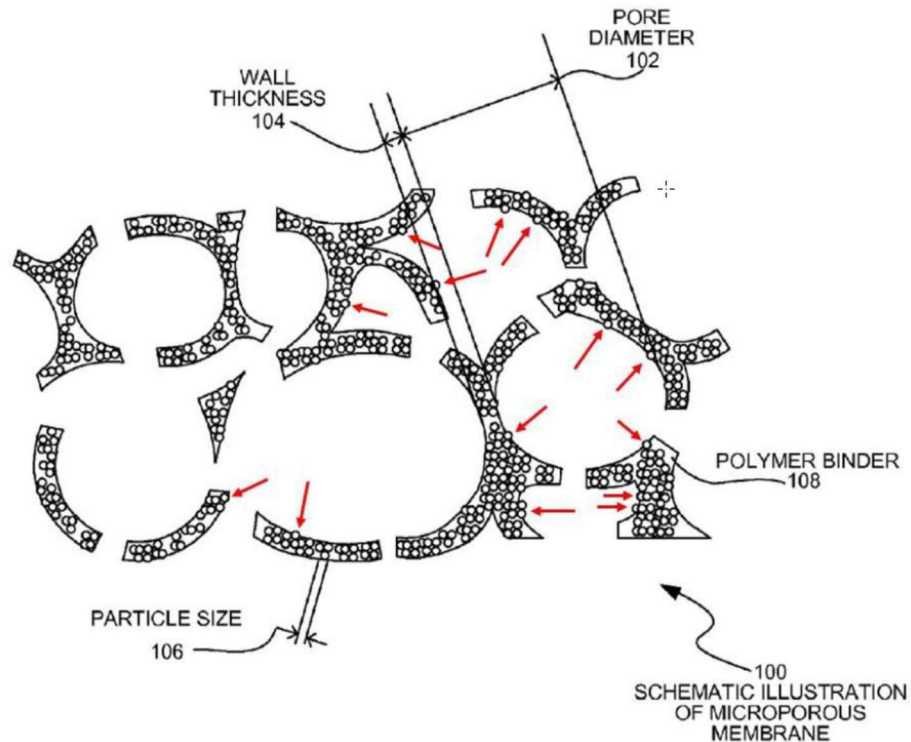


FIG. 1

191. Unlike Murakami (which encourages a very low ratio of binder to inorganic particles), Beard teaches using a high ratio of polymer (binder) to inorganic particles in its porous layer. *See* Ex. 1010 at [0029] (“In some embodiments, the volume of particles to polymer may be 1:1, 1:2, 2:1, 1:1.5, 1.5:1, or some other ratio.”). This means the relative volume of binder in Beard is as low as 2:1 (half as much particles as binder) and as high as 1:2 binder (twice as much binder as particles), or in other words: 33% to 67% binder by volume. And in the examples, for mass percent of solids in the porous layer, Beard discloses using only

70% by mass inorganic particles (meaning up to 30% by mass can be binder). Ex. 1010 at [0054]. This much higher percentage of binder means that, unlike in Murakami, there is enough binder in Beard to *fully encapsulate* all the inorganic particles, which results in a “filled polymer” where the polymer wets or coats all the filler particles. Ex. 1010 ¶ 85 (describing, in the “most optimized” pore structure, that “the filler and polymer under favorable thermodynamics coat/wet/bond and hence create the strongest possible filled polymer system”). Thus, a POSITA would have understood that even in Figure 1, any of the incredibly small particles that are not flush with the other particles to form the inner ring of the pore wall are still to be coated or covered with at least a thin layer of binder due to the thermodynamic chemical interactions between Beard’s inorganic filler particles and its polymer that create a driving force for Beard’s polymer to coat or spread on the surface of Bear’s filler particles, separating those inorganic particles from the pore itself. Ex. 2033 (Gido Depo. Tr.) at 221:6-222:8 (“Q And by -- by wets, it also means coats, right? A Wetting would be a thermodynamic driving force to coat or spread on the surface to the extent that it does that more or less or completely everywhere, I don't know, but it certainly provides a -- a thermodynamic drive to do that. Q And that's due to just chemical interactions between the polymer and the filler particle? A Yeah, that's -- Q That -- that result? A Yeah.”). In Beard’s Fig. 3, it teaches that Fig. 3 shows “the small bumps and protrusions of the filler material *fully encapsulated* by the

polymer. The *polymer has fully wet the TiO₂ filler*, yet the microporous structure remains.”) Ex. 1010 (Beard) ¶ 50 (emphasis added), Fig. 3.

192. *Second*, even if Beard discloses that it is *possible* for some inorganic particles to barely extend into the pores—which it does not because the particles are coated in binder—Beard teaches that this possibility should *is not preferable and should be avoided*. If anything, Beard teaches away from pores that “at least comprise part of the inorganic particles.” It states: “When 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]. Thus, a POSITA would understand that the goal of Beard is to *not* have the pores comprise any filler (e.g. inorganic particles or parts thereof). Instead, Beard discloses limiting the inorganic particles’ “interference in pore creation.” *Id.* Including at least parts of the inorganic particles as part of the pores would run counter to this direct teaching of Beard.

193. Moreover, Figure 3 of Beard illustrates an example 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]. As explained above, it is in a scenario like this, where the inorganic particles are coated

or wet by polymer, that Beard teaches the “most optimized” porous film is obtained. Ex. 1010 ¶ [0085].

194. Thus, a POSITA combining Murakami and Beard would be motivated to ensure that the inorganic particles in the combination do *not* extend into the pores. This would be the natural way to minimize the inorganic particles’ “interference in pore creation” and achieve the best results suggested by Beard.

2. Petitioner Fails to Show that a POSITA Would have Combined Beard with Murakami to Arrive at the Claimed Invention

195. Dr. Guido opines that a POSITA would have been motivated to combine Beard and Murakami because Beard teaches that its “highly filled membrane” leads to “good results.” Ex. 1003 ¶ 179. I disagree that a POSITA would have been motivated to combine Beard with Murakami.

196. I explained many reasons why a POSITA would not have been motivated to combine Murakami and Beard in my Preliminary Declaration (Ex. 2015 ¶¶ 135-149), and I incorporate that discussion by reference herein. I understand that, while the Board preliminarily found motivation to combine for the purposes of institution, it also stated that “Patent Owner raises some interesting arguments that should be developed further.” Paper No. 10 at 36. Thus, I provide additional analysis below to elaborate on the concepts and arguments presented in my Preliminary Declaration.

a. Murakami and Beard Rely on Very Different Variables, and Thus Have Fundamentally Different Pore Structures

197. As explained above in Paragraphs 16-39, there are many different variables that affect a porous layer's pore structure and thus its properties. Changing any one of these factors can have a huge impact on the resulting pore structure.

198. A POSITA would have understood that Murakami and Beard have completely incompatible pore structures, at least because they rely on very different key variables, including (1) different particle sizes and distributions, (2) different relative amounts of binder, and (3) different mixing and dispersing procedures. A change in any one of these variables alone would have a significant impact on pore structure. The fact that Murakami and Beard differ greatly on what to do for all three of these variables means that their resulting pore structures are fundamentally incompatible with one another, and a POSITA would not have been motivated to combine the references.

199. **First**, Murakami and Beard use incompatible particle sizes and distributions. As for size, Beard teaches using “extremely small” inorganic particles. *E.g.*, Ex. 1010 ¶ [0064] (“In order to form a highly porous material, ***extremely small particles*** may be blended into a polymer melt or solvent solution with both a polymer and a liquid.”); Abstract (“Within the pore walls that may be less than 0.02 microns in width, a densely packed filler material may have an ***average diameter of less than***

0.005 microns.”); ¶ [0037] (“The TiO₂ particles are *on the order of or smaller than the cell wall thickness 208.*”). A POSITA would have understood that this “extremely small” size of inorganic particles is critical to achieving Beard’s pore structure of pore walls made of “filled polymer” binder that is packed tightly with inorganic particles within the binder itself. *See, e.g., id.* ¶ [0086] (attributing Beard’s “[g]ood results” to the fact that “the solid particles are contained exclusively or largely within the pore walls”).

200. As for size distribution, Beard teaches that, at most, the average size (D50) of all particles should be within a relatively narrow range: “from 0.005 to 0.1 microns, but may vary from 0.001 to 0.2 microns in some embodiments.” *Id.* ¶ [0022]; Ex. 2033 at 180:15-181:8. The Abstract of the invention lists the preferred D50 value as 0.005 microns. Ex. 1010 at Abstract. Beard also discloses a *maximum* particle size, as it teaches that the maximum particle size should not exceed the wall thickness. *See, e.g.,* Ex. 1010 at [0028] (disclosing the lowest ratio of wall thickness to maximum particle size as 1:1); Claims 1-20 (all requiring “pore wall thickness greater than said maximum filler size”). Together, a POSITA would have understood these disclosures to mean that Beard’s distribution should be a D50 value that falls within the range of 0.001 to 0.1 micron, preferably around 0.005 microns, and a maximum particle size that is the thickness of the binder walls (which Beard discloses is 0.1 micron at most).

201. Although Dr. Guido argues that the particle size in Beard may go up to 0.2 microns because of the “some embodiments” language in paragraph 22, these “embodiments” where the particle size may extend that high clearly do not include the Fig. 1 embodiment, which Dr. Guido relies on for the pore structure limitations in this ground. To the contrary, Fig. 1 shows the inorganic particles as being much smaller than the wall thickness. Ex. 2033 at 190:20-22 (“You know, in Figure 1, those particles happen to be small relative to the cell walls.”). Moreover, a POSITA would not ignore the multiple disclosures in Beard that the particle size should not exceed wall thickness and that the particles should be packed tightly in the pore walls, which is the key point of Beard. And, even if a POSITA were to interpret Beard as disclosing an average particle size up to 0.2 microns, a POSITA would still agree that the range of 0.001 microns to 0.2 microns is very small range as I discuss below, so this difference would not alter my opinions that Beard’s sizes and distribution are incompatible with Murakami’s (and Akiike’s, as discussed with respect to Ground 7).

202. Like with small size, a POSITA would have understood that this narrow size distribution is important to achieve the pore structure exhibited in Beard. If the particle sizes vary too much from one another (i.e. if there were a broader size distribution). then the presence of smaller particles would increase the degree of interaction between particles and binder (see discussion in Paragraph 30 above) and

disrupt or otherwise modify the pore structure relative to a more uniform distribution. Additionally, a wider distribution of particles can lead to blockage of pores due to the more efficient packing of particles (in this case efficiency is an undesired quality). Either of these are outcomes that Beard is explicitly designed to avoid. *See, e.g.*, Ex. 1010 ¶ [0086] (“When 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.”).

203. In contrast to Beard, Murakami relies on much bigger particle sizes, a much broader size distribution, and minimal use of binder. *See, e.g.*, Ex. 1005 ¶ [0018] (“The porous layer of the present invention preferably contains a filler in which, in terms of average particle diameter obtained based on a volume, (i) D10 is 0.005 um to 0.4 um, D50 is 0.01 um to 1.0 um, and D90 is 0.5 um to 5.0 um.”).¹³ A POSITA would have understood that these much larger particle sizes and broader

¹³ As explained above, these values reflect the starting material used in Murakami, and the particles in the resulting porous membrane would be significantly altered by high-pressure dispersion. Nonetheless, Petitioner relies on these values for the claimed D10, D50, and D90 values, and so I use them here to explain why Petitioner’s arguments lack merit.

size distribution are mutually exclusive from the extremely small particle sizes and narrow size distribution of Beard. As I explained in my Preliminary Declaration, “a POSITA would have had to make a choice . . . (1) choose between the small particle sizes of Beard or the large particle sizes of Murakami, or (2) pick some middle ground between the two references, using neither the invention of Beard *nor* Murakami.” Ex. 2015 ¶ 138. Either way, the resulting porous layer would not meet the claimed limitations. *Id.*

204. If a POSITA were to use the small particle sizes and narrow size distribution of Beard, then “the combination does not disclose either the claimed limitations of the pores comprising part of the inorganic particles or the claimed distribution ranges.” Ex. 2015 ¶ 139. For example, using the extremely small particle sizes disclosed in Beard (0.001 to 0.2 microns) means having *no* particles greater than 0.2 microns, thus failing to meet at the claim requirement that Dv90 is in a range of 1 µm to 10 µm.

205. Conversely, if a POSITA were to use the larger particle sizes and broader size distribution of Murakami, then “the particles would no longer be small enough to fit within the walls (i.e. be fully subsumed by the binder)” like in Beard’s pore structure. Ex. 2015 ¶ 140. If D10 is 0.005 µm to 0.4 µm, D50 is 0.01 µm to 1.0 µm, and D90 is 0.5 µm to 5.0 µm, like Dr. Guido argues is the case in Murakami, then (as I previously explained) “this would mean that the vast majority of inorganic

particles would be far larger than the pore wall (i.e. binder) thickness in Beard, which is 0.02 um, and the particles would extend far beyond the binder.” Ex. 2015 ¶ 140. The resulting pore structure would not be like that of Beard (pores delineated by walls made of binder, tightly packed with inorganic particles), but rather would be like that of Murakami (pores formed by gaps between inorganic particles). It is unclear how the Petition or Dr. Guido suggest these inconsistencies between pore types, pore sizes, wall sizes, and particle sizes be resolved when combining the two references. Indeed, Beard itself confirms that the pore structure of Murakami (pores formed by gaps between inorganic particles) would be the resulting pore structure if larger particle sizes are used. This is what happens in the alternative embodiment in Beard, 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). Ex. 1010 at [0086]. In that embodiment, like in Murakami, neither of the pore structure requirements are met.

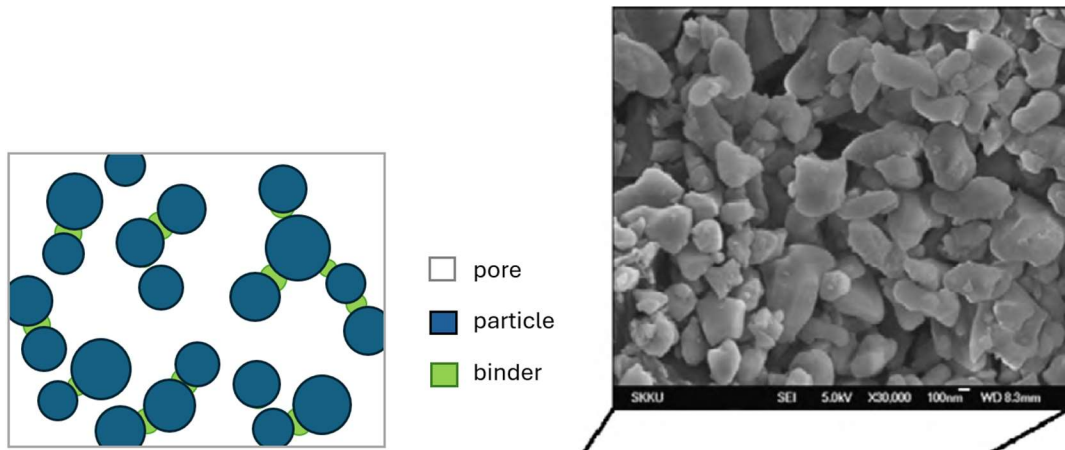
206. Moreover, even if Beard is found to disclose a few small particles extending to into the walls based on the red arrows Petitioner draws in Figure 1, Beard still is explicit that its “good results” are the effect of “solid particles [being] contained exclusively or largely within the pore walls,” allowing “an open, continuous pore structure” throughout the film. Ex. 1010 at [0086]. It further teaches

against allowing “filler additives” from “block[ing] the pore pathways” or negatively impacting “total porosity and pore structures.” *Id.* A POSITA would have understood that the effect of a very small inorganic particle coated in binder appearing to “peek out” from the binder wall, as allegedly shown in Figure 1 of Beard, is ***very different*** than the effect of all or most of Murakami’s larger particles extending much, much further into the pores and blocking the porous pathways. Given these much larger particle sizes, a POSITA would have understood that the particles would now rise to the level of “being allowed to block the pore pathways” and negatively impact “total porosity and pore structures.” *Id.* Nor would a POSITA have been motivated to adjust Beard’s wall thicknesses to accommodate Murakami’s larger particles because they would know that exceeding Beard’s maximum pore wall thickness of 0.1 microns would negatively affect Beard’s other variables, such as pore size and porosity. A POSITA thus would not be motivated to make this combination, and in fact would avoid it.

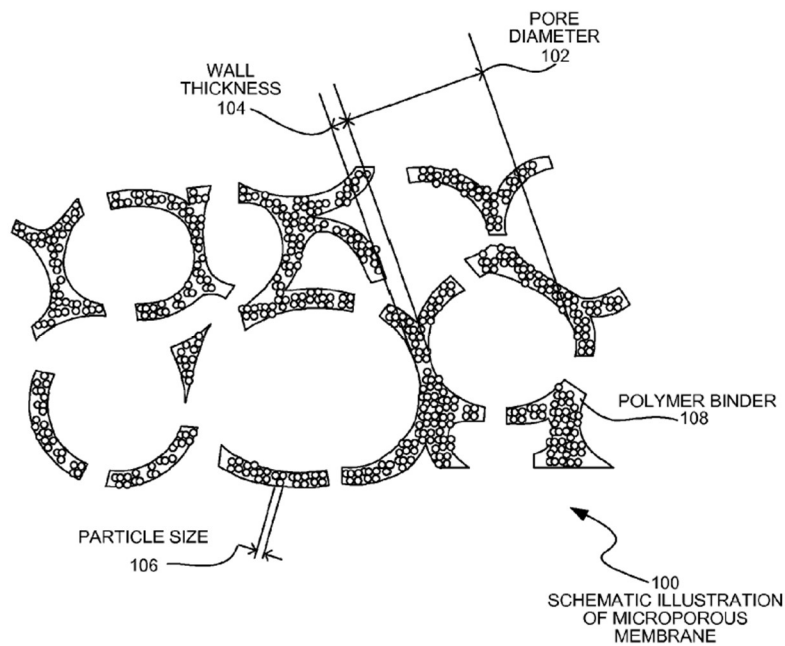
207. **Second**, Murakami and Beard use incompatible relative amounts of binder. As explained in Paragraphs 54, 95-98, and 110, the relative amount of binder used influences whether pores can be “formed by the binder” or not. If a porous layer does not contain enough binder, then the binder cannot be the component of the layer that forms the pores. To achieve its pore structure (where the inorganic particles are encapsulated in binder), Beard requires a relatively high amount of binder. In

particular, it discloses using at least 50% and as high as 200% by volume of binder compared to the volume of inorganic particles (that is, from 33% binder/67% filler to 67% binder/33% filler by volume). Ex. 1010 ¶ [0029] (“In some embodiments, the volume of particles to polymer may be 1:1, 1:2, 2:1, 1:1.5, 1.5:1, or some other ratio.”). This is the exact opposite of what Murakami teaches, which is that the less binder you use relative to the inorganic particles, the better. *See, e.g.*, Ex. 1005 ¶ [0070] (teaching preferably using only between 1 to 10% by mass of binder compared to mass of inorganic particles, and most preferably using only 1% mass of binder). These teachings are fundamentally incompatible with one another, and thus a POSITA would have to choose one approach or another and would not have been motivated to combine the two.

208. That these relative amounts of binder are incompatible (and lead to incompatible pore structures between Beard and Murakami) is evident when one considers the resulting pore structures of each reference. In Murakami, where very little binder is used, the pores are simply gaps between inorganic particles (as shown below in my illustration on the left and the SEM on the right). The exemplary SEM image on the right is of a high-loading particle layer that a POSITA would expect to be similar in structure to Murakami. Ex. 2052 at Fig. 2.



209. But in Beard, where the amount of binder used is much, much greater than in Murakami, there is enough binder for the binder to create pore walls and fully encapsulate and coat the small inorganic particles in Beard.



210. This pore structure of Beard (binder walls packed tightly with inorganic particles) is simply not possible using the minimal amount of binder that Murakami

teaches is preferable. This is especially true if using the larger particle sizes and broader size distribution of Murakami, which would require even more binder than Beard to fully encompass the inorganic particles to create binder walls. For example, the largest possible particle size in Beard is 0.2 μm (Ex. 1010 ¶ [0022]), whereas Murakami's broadest range includes particle sizes ranging to at least 5.0 μm (Ex. 1005 ¶ [0018]) and at least 1.03 μm in Example 1 (*id.* at ¶ [0141]) and 1.53 μm in Example 2 (*id.* at ¶ [0161]). Coating a 5.0 μm particle, 1.03 μm particle, and 1.53 μm particle necessarily requires more binder than coating a 0.2 μm particle.

211. ***Third***, Murakami and Beard use incompatible mixing and dispersing procedures, as well as different methods of solidification. As explained above in Paragraphs 16-39, the manufacturing procedures a POSITA uses to form a porous layer will greatly impact the resulting pore structure of that porous layer. A porous layer formed using a simple solvent mixture and drying technique, for example, will have a very different pore structure than a porous layer formed using the NIPS process (which forms pores by coagulating the binder, i.e. drawing the binder out of solution ***before*** drying). In addition, using a technique such as high-pressure dispersion will have a significant impact on how large the inorganic particles are and also how “spread out” they are in the porous layer. As I previously explained, Murakami “teaches using high-pressure dispersion in making its porous layer, whereas Beard does not. Dr. Guido does not explain which mixing and dispersion

technique to use, and a POSITA would not be able to use both.” Ex. 2015 ¶ 143. Moreover, Dr. Guido does not explain which of the pore formation processes, Beard or Murakami, to use. And Murakami teaches a POSITA *not* to use a solvent substitution process for its preferred examples, Examples 1 and 2.

b. Murakami and Beard Have Very Different Goals

212. The purpose of Murakami is to decrease variability in voidage (so as to improve capacity retention). *See e.g.*, Ex. 1005 ¶ [0088]. A POSITA would have recognized that, in order to achieve that goal, they would need to avoid a porous structure that is highly irregular. As I explained in my Preliminary Declaration, Beard’s “Fig. 2 shows a porous structure that is highly irregular.” Ex. 2015 ¶ 147. This irregularity would lead to increased variability in voidage, something that a POSITA applying Murakami would want to avoid.¹⁴

¹⁴ I understand that the Board views Fig. 2 as a separate embodiment not relied on by Petitioner. Paper No. 10 at 33-34. But even if Petitioner did not cite to Figure 2, it still illustrates to a POSITA reading Beard the type of real-world (and not merely conceptual) 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 51:13-53:1, 63:9-21, 64:16-65:21.

213. Regardless, if Dr. Gido is correct that Beard discloses pores comprising at least a part of the inorganic particles (which it does not for the reasons explained above), a POSITA would have even more reason not to adopt Beard's pore structure. This is because a POSITA would recognize that inorganic particles extending partially or wholly into pores would *increase* variability in voidage in the porous layer. This would directly contradict the entire point of Murakami, which is to *minimize* variability in voidage. Thus, if one assumed that Beard did disclose the pore structure claimed in the '148 Patent, a POSITA would want to *avoid* using Beard's pore structure—not adopt it.

c. There Is No Reasonable Expectation of Success In Combining Beard and Murakami

214. *Finally*, even if a POSITA were to combine Beard with Murakami, a POSITA would not have had a reasonable expectation of success in combining these references to arrive at the claimed invention. Dr. Gido suggests that a POSITA could use the particle sizes of Murakami but arrive at the porous structure of Beard. This is not the case.

215. A POSITA would have understood that Beard achieved its porous structure at least by using (1) a particular particle size (preferably 0.005 μm , or at most 0.001 to 0.2 μm); and (2) a specific ratio of binder to inorganic particles (1:1, 1:2, 2:1, 1:1.5, 1.5:1). A POSITA would have recognized that, by changing either or

both of these variables (as one would have to do based on Murakami), an entirely different pore structure would result. Thus, it is not possible to have the pore structure of Beard (pores formed by the binder and, according to the Petitioner, particles extending into the pores) without also adhering to the particle size distribution and binder limitations disclosed in Beard. Ground 4 requires ignoring at least the particle size distribution of Beard and replacing it with the much larger size distribution of Murakami. One cannot make this change without altering the pore structure of Beard, thereby failing to meet the requirements that the pores be formed by the binder and comprise at least a part of the inorganic particles.

216. Even if one conceived of this combination as simply applying Beard's teaching of packing the pore walls tightly with inorganic particles, while still maintaining the remaining elements of Murakami, a POSITA would have understood that such a combination is impossible. As explained in detail in Paragraphs 84-113, things like the particle size distribution, amount of binder, and other explicit disclosures of Murakami dictate that the pore structure is one in which the pores are simply gaps between the inorganic particles. This is *not* the case with Beard's embodiment 100, in which the pores are delineated by the "filled polymer" binder pore walls instead of the edges of the inorganic particles. There simply is no binder pore wall in Murakami for a POSITA to pack inorganic particles into, like Petitioner suggests doing. Thus, in order to follow the packing teaching of Beard, a

POSITA would understand they would need to change almost everything about Murakami's pore structure in order to first form binder pore walls to pack the inorganic particles into. Changing Murakami's pore structure to conform with Beard requires at least changing the inorganic particle sizes to fit into the pore walls of Beard, which are *at most* 0.1 μm . Ex. 1010 at 21; Ex. 2033 at 189:17-190:13. And if one changes the particle sizes of Murakmi to fit within a pore wall that is at most 0.1 μm , the biggest possible particle size would also be 0.1 μm , meaning that the combination no longer meets the required particle size distribution requirements (including $Dv50 = 0.2 \mu\text{m}$ to $5 \mu\text{m}$ and $Dv90 = 1 \mu\text{m}$ to $10 \mu\text{m}$). Nor is there any motivation to use or reasonable expectation of success in using thicker walls than the maximum disclosed in Beard, because a POSITA would have recognized that thicker binder walls would be more likely to swell in electrolyte and close the pores. Likewise, a POSITA would not have been motivated to use or have had a reasonable expectation of success in using the thin pore walls of Beard (at most 0.1 μm) with the 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 a POSITA would have understood that this creates the exact situation Beard warns against: "filler additives [being] allowed to block the pore pathways." Ex. 1010 ¶ [0086]. It would also mean that particles would be more likely to fall off, an outcome that Dr. Gido agrees a POSITA would want to avoid. Ex. 2033 at 93:1-94:6.

217. In sum, effectively combining Beard with Murakami is not feasible because the two have entirely incompatible pore structures. And, if one were to combine the references, the result would not resemble the claimed inventions of the '148 Patent. No combination of elements of both references would simultaneously meet all the claim limitations. If Beard's extremely small particles are used, the particles would not meet the claimed size distribution. If Murakami's large particles are used, the pores would not be formed by the binder, but would instead be formed by gaps between particles. If Beard's relatively large amount of binder is used, then the particles would be fully encapsulated by the binder and do not comprise part of the pores. If the very small amount of binder in Murakami is used, then the pores would not be formed by the binder, but would instead be formed by gaps between inorganic particles.

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

218. It is my understanding that in Ground 5, Petitioner asserts and Dr. Gido opines that Murakami, Beard, and Honda render obvious Claims 3 and 12. Pet. at 48-56; Ex. 1003 ¶¶ 162-81.

219. 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 2.

220. Moreover, a POSITA would not be motivated to combine Murakami, Beard, and Honda with a reasonable expectation of success because Beard and Honda have incompatible pore wall thicknesses. Beard provides that “[t]he 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.” Ex. 1010 at [0022]. In contrast, Honda discloses thicker pore walls: 0.1 to 2 μm . Ex. 1007 at [0045]. Neither the Petition nor Dr. Gido explain which wall thickness a POSITA would use and why, and whether the use of Honda’s thicker wall thickness would mean that the particles are even more likely to be fully encapsulated by the binder and would not stick out into the pores themselves.

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

221. It is my understanding that in Ground 6, Petitioner asserts and Dr. Gido opines that Murakami, Beard, and Tanaka render obvious Claims 4 and 13. Pet. at 48-56; Ex. 1003 ¶¶ 162-81. These claims are reproduced above with respect to Ground 3.

222. 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 2.

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

223. Petitioner contends that Beard and Akiike render obvious Claims 1-3, 5-12, and 14-19 of the '148 Patent.

224. Dr. Guido argues that a POSITA would combine Beard's pore structure with Akiike's particle sizes. Not only do I disagree that a POSITA would combine Beard and Akiike, but even if they were to combine these references, the combination of Beard and Akiike fails to disclose or render obvious all the claimed elements for at least the following reasons.

1. Neither Beard nor Akiike Disclose "The Pores . . . At Least Comprises a Part of the Inorganic Particles"

225. Dr. Guido's combination relies on Beard alone for the pore structure limitations (i.e. formed by a binder and comprising a part of the inorganic particles). For the same reasons noted above with respect to Beard in Ground 4, it is my opinion Beard does not disclose or render obvious "the pores at least comprises a part of the inorganic particles." For this reason alone, this combination fails.

2. Akiike Does not Disclose or Render Obvious Dv10, Dv50, or Dv90 in a Porous Layer

226. Dr. Guido opines that Akiike discloses "wherein the inorganic particles have particle sizes that Dv10 is in a range of 0.015 μm to 3 μm ," "Dv50 is in a range of 0.2 μm to 5 μm , and" "Dv90 is in a range of 1 μm to 10 μm ," as recited in Claim 1. I disagree for the reasons set forth in my Preliminary Declaration.

227. Further, I disagree at least because the D10, D50, and D90 values disclosed in Akiike are not representative of the actual size of the inorganic particles in Akiike's porous membrane layer.

a. Akiike's D10, D50, and D90 values are not representative of non-conductive particles alone.

228. Example 1 of Akiike explains that the porous membrane slurry is produced by first forming a dispersion of non-conductive (α -alumina) particles in an aqueous solution of a water-soluble polymer, and then mixing the non-conductive particle dispersion with an aqueous dispersion of a particulate (water-insoluble) polymer and an aqueous solution of a nonionic surfactant. Ex. 1011 ¶¶ [0235], [0238], [0238], and [0241]; *see also id.* at ¶ [0067]. The other examples in Akiike similarly make their “porous membrane slurry” in this way. *See, e.g.*, Ex. 1011 ¶ [0026]. Thus, Akiike's porous membrane slurry is an aqueous dispersion of not only non-conductive particles, but also other particles, including the particulate polymer. *Id.* at ¶ [0241].

229. Akiike explains that the size of the non-conductive particles are then measured in the porous membrane slurry. *Id.* at ¶ [0243], Table 1. Results for these measurements of the porous membrane slurry are reported in Akiike's tables, and Akiike explains that “D10, D50, and D90 of the non-conductive particles in the porous membrane slurry may be obtained by measuring the accumulated particle

size distribution of the non-conductive particles,” and the accumulated particle size distribution of the non-conductive particles in the porous membrane may be measured by a laser diffraction method.” *Id.* at ¶ [0036]. Akiike states, “[t]he porous membrane slurry was measured by a laser diffraction particle size distribution measuring apparatus (SALD-2000” manufactured by Shimadzu Corp.) to obtain D10, D50, and D90 of the non-conductive particles.” *Id.* at ¶ [0195]. Thus, Akiike’s D10, D50, and D90 values reported in the tables in Akiike (and elsewhere in Akiike) are obtained from D10, D50, and D90 measurements on the porous membrane slurry, which includes both non-conductive particles and polymer particles.

230. A POSITA would understand that using laser diffraction to measure particle sizes does not measure a single particle diameter or a precise volume, but rather how much a particle diffracts light from its original path. Using Fraunhofer or Mie diffraction theory, and an algorithm that assumes each particle is a perfect sphere, the volume and associated diameter of the particle is estimated. Exs. 2042, 2043. After particles are measured using a laser diffraction measuring device, a particle distribution is constructed in which, for example, D90 defines the point where 90% of the particles are smaller and 10% of the particles are bigger than that diameter.

231. As mentioned above, a laser diffraction measurement detects diffracted light, but it cannot differentiate between particles made of different materials. *Id.* In

the case of Akiike, the laser diffraction measurement device cannot distinguish light diffracted from non-conductive particles from light diffracted from other particles in the slurry, such as the particulate polymer. Consequently, a particle size distribution constructed from laser diffraction measurements on a sample that includes different types of particles would be representative of the sizes of all the different particles, not just one type of particle within the sample. Thus, although the D10, D50, and D90 values in Akiike are purported to reflect the size of the non-conductive particles, Akiike's description of how the particles are measured would suggest to a POSITA that those measurements actually (and necessarily) reflect the size of all particles included in the slurry, which includes at least the non-conductive particles and the particulate polymer. Akiike ¶¶ [0195], [0243], Table 1.

TABLE 1

Results of Examples 1 to 4				
	Ex. 1	Ex. 2	Ex. 3	Ex. 4
Non-conductive particles				
Amount (parts)	100	100	100	100
BET specific surface area (m ² /g)	5.5	7.8	5.5	5.5
D10 (μm)	0.39	0.33	0.39	0.39
D50 (μm)	0.87	0.71	0.87	0.87
D90 (μm)	1.38	1.25	1.38	1.38
Aspect ratio	1.2	1.2	1.2	1.2
Type of particulate polymer	A	A	B	C
Amount of particulate polymer (parts)	6	6	6	6
Amount of monomer I (parts)	2	2	19.85	20
Type of monomer II	BA	BA	2EHA	BA
Amount of monomer II (parts)	93.8	93.8	77.95	73.8
Type of monomer III	MAA	MAA	MAA	MAA
Amount of monomer III (parts)	2	2	2	4
Type of monomer IV	AGE/NMA	AGE/NMA	AMA	AGE/NMA
Amount of monomer IV (parts)	1/1.2	1/1.2	0.2	1/1.2
Type of water-soluble polymer	A	A	A	A
Amount of water-soluble polymer (parts)	0.5	0.5	0.5	0.5
Ratio of acid components	0.25	0.25	0.25	0.25
Mw of water-soluble polymer	6000	6000	6000	6000
Type of thickener	CMC	CMC	CMC	CMC
Amount of thickener (parts)	1.5	1.5	1.5	1.5
Ratio of thickener/water-soluble polymer	3	3	3	3
Type of surfactant	PO/EO = 50/50	PO/EO = 50/50	PO/EO = 50/50	PO/EO = 50/50
Amount of surfactant (parts)	0.5	0.5	0.5	0.5
Electrical conductivity (μS/cm) *	10	10	10	10
Solid content concentration of dispersion (wt %)	50	50	50	50
Dispersion condition (Wh/kq)	5.4	6	5.4	5.4
Solid content concentration of slurry (wt %)	40	40	40	40
Iron ion concentration (ppm)	18	18	18	18
Water content of separator	A	A	A	A

232. As shown in Akiike's Table 1, which is representative of the rest of the examples as to the weight percent of particulate polymer, the particulate polymer constitutes approximately 6% of the total weight of particles in slurry (6 parts of particulate polymer mixed with 100 parts of non-conductive particles). *Id.* ¶ [0009],

Table 1. However, because the '148 patent claims focus on volume-based particle distribution, we can estimate the volume percentages of the non-conductive particles and particulate polymer in Akiike's slurry using density estimates for the non-conductive particles and particulate polymer.

233. Akiike discloses that "particulate polymer A" in Example 1, for example, is butyl acrylate polymer (the other components used during production of particulate polymer A will have a negligible impact on this volume calculation, so I ignore those components for the purpose of this estimate). Akiike at ¶¶ [0235]-[0236]. The density of butyl acrylate is approximately 1.06 g/cm.³ Ex. 2049. The non-conductive particles in this example are aluminum oxide, which has a density of approximately 3.987 g/cm.³ Ex. 2050. Using these density values, the volume percentages of the particulate polymer and the non-conductive particles can be calculated as follows:

234. Particulate Polymer:

$$\frac{\text{parts by weight}}{\text{density butyl acrylate}} = \frac{6g}{1.06 \text{ g/cm}^3} = 5.66 \text{ cm}^3$$

235. Non-conductive Particles:

$$\frac{\text{parts by weight}}{\text{density aluminum oxide}} = \frac{100g}{3.987 \text{ g/cm}^3} = 25.08 \text{ cm}^3$$

236. The resulting volume percentage attributable to the particulate polymer is calculated as follows:

$$\frac{\text{volume particulate polymer}}{\text{total particulate volume}} = \frac{5.66\text{cm}^3}{5.66\text{cm}^3 + 25.08\text{cm}^3} = 18.4\%$$

237. Thus, the particulate polymer constitutes roughly 18 percent of the particles (by volume) within the slurry of Example 1, for instance, suggesting that the presence of the particulate polymer has a significant impact on the calculated D10, D50, and D90 particle distributions measured for the slurry, as taught by Akiike.

238. Moreover, Akiike explains that the particulate polymer has a volume average particle diameter of 50nm to 500nm (0.05 μm to 0.5 μm) (*id.* ¶ [0095]) – lower than 0.87 μm D50 value that Akiike attributes to the “non-conductive particles” in Example 1, for instance. Akiike does not disclose a D90 value for the particulate polymer. So, while Akiike provides enough information to determine that the presence of the particulate polymer will impact any calculated particle distribution of the slurry, Akiike does not provide sufficient information to estimate whether the non-conductive particles alone would have a particle distribution that is lower or higher than the total particles in the slurry.

239. Because Akiike’s particulate polymer is provided in non-negligible quantities and different particle sizes as compared with the measured particle size

distribution of the slurry, Akiike does not provide adequate information to deduce particle size distribution measurements of the non-conductive particles alone. In other words, it would be impossible for the D10, D50, and D90 values in Tables 1-5 to only correspond to the non-conductive particles if laser diffraction were used to measure particle sizes of the porous membrane slurry as described by Akiike. *Id.*

240. Akiike's disclosure does not provide sufficient details to calculate Dv10, Dv50, or Dv90 values of the non-conductive particles in the absence of particulate polymer. First, Akiike explains that the non-conductive particles are subject to manufacturing processes that would change the particle size distribution when forming the slurry. For example 1, for instance, Akiike explains that, prior to production of the slurry, a "vibrating ball mill" is first used "to obtain α -alumina particles having a volume average particle diameter of 0.6 μm ." *Id.* ¶ [0233]; *see also id.* ¶ [0032]. In other words, the D50 of α -alumina particles prior to production of the slurry is 0.6 μm . After mixing into slurry, Akiike's Table 1 indicates that the D50 of the non-conductive particles in the slurry is 0.87 μm . A POSITA would understand this increase in size is due to some degree of aggregation of the particles (*see e.g. id.* ¶ [0037]) and also the presence of other particles (e.g., the particulate polymer) in the slurry. The POSITA would therefore recognize that the difference in D50 particle distribution of the non-conductive particles before addition to the slurry versus the D50 particle distribution of the slurry demonstrates that the D10,

D50, and D90 values reported in Table 1 cannot represent the particle distributions of the inorganic particles alone. *See e.g. id.* ¶¶ [0037] [0095]. Akiike does not explain how to exclude the particulate polymer from these laser diffraction measurements.. *See e.g. id.* ¶¶ [0037] and [0095].

241. Therefore, at least because Akiike performs the D90 measurements on the porous membrane slurry, which includes particles other than the non-conductive particles, it is impossible to determine the actual D10, D50, or D90 of the non-conductive particles in Akiike's porous membrane layer.

b. Akiike's D10, D50, and D90 values are applicable to slurries containing organic and/or inorganic non-conductive particles

242. 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]). Thus, Akiike teaches that "the inorganic particles and the organic particles may be used [alone or] in combination as non-conductive particles." Ex. 1011 ¶ [0042]. When describing the D10, D50, and D90 values, Akiike does not distinguish between inorganic and organic particles but instead refers only to "non-conductive particles". Ex. 1011 ¶ [0031] ("the *non-conductive particles* in the porous membrane slurry have D10 of preferably 0.2 μm or more and more preferably 0.3 μm or more, and preferably 0.4 μm or less"), ¶ [0032] ("the *non-conductive particles* in the porous

membrane slurry have D50 of preferably 0.5 μm or more and more preferably 0.7 μm or more, and preferably 0.9 μm or less.), ¶ [0033] (“the *non-conductive particles* in the porous membrane slurry have D90 of preferably 1.0 μm or more and more preferably 1.2 μm or more, and preferably 3.0 μm or less, more preferably 2.0 μm or less, and further preferably 1.5 μm or less.”). A POSITA would therefore understand that the ranges of D10, D50, and D90 values provided in Akiike’s paragraphs ¶¶ [0031], [0032], and [0033] are not just for porous membrane slurries that include inorganic particles, but encompass all porous membrane slurries that include inorganic particles, organic particles, or a combination of inorganic and organic particles.

243. A POSITA would therefore understand that the ranges provided in paragraphs ¶¶ [0031], [0032], and [0033] of Akiike are not, in their entirety, applicable to porous membrane slurries including only inorganic non-conductive particles. Instead, a POSITA would understand that only values within the much narrower ranges shown in Akiike’s Tables 1-5 would be allegedly applicable to porous membrane slurries including inorganic non-conductive particles, and that those ranges would reflect the size of not only the inorganic non-conductive particles, but all particles included in the porous membrane slurries (e.g., including at least the particulate polymer).

3. Petitioner Fails to Show That a POSITA Would Have Combined Akiike with Beard to Arrive at the Claimed Invention

244. Dr. Guido opines that a POSITA would have been motivated to combine Beard and Akiike because Beard discloses “a highly packed spherical filler material . . . bound with a polymer” but does not provide size distributions of the filler particles. Ex. 1003 ¶ 200. According to Dr. Guido, “[l]acking these implementation details, it is my opinion that a POSITA would have looked to a similar separator porous membrane reference like Akiike for guidance on the appropriate size distributions for Beard’s filler particles.” *Id.* He also rationalizes that there is a motivation to combine because Akiike and Beard both teach using the same type of inorganic particles, titanium dioxide. *Id.* ¶ 201. Dr. Guido then relies on Akiike’s disclosure about its size distributions to argue that a POSITA would have been motivated to arrive at the claimed ranges. *Id.* ¶¶ 202-04.

245. In its Institution Decision, I understand that the Board preliminary found that Petitioner met its burden to establish motivation to combine and reasonable expectation of success because “a person of ordinary skill in the art would have looked to Akiike for teachings regarding particle size and particle size distributions because of the benefits it teaches that these distributions have on improving battery properties.” Paper No. 10 at 43.

246. Respectfully, I disagree that a POSITA would have been motivated to use the particle sizes and distributions disclosed in Akiike. Moreover, even if they were to use Akiike's particle sizes and distributions, a POSITA would not have been able to achieve Beard's pore structure using Akiike's particles. I incorporate by reference Paragraphs 159-174 of my Preliminary Declaration and provide additional analysis below to elaborate on my opinions in light of the Board's Institution Decision.

247. ***First***, I respectfully disagree with the Board's conclusion that Beard does not "have sufficient implementation details, . . . especially given the teachings of Akiike on the importance of controlling the particle size distribution overall." Paper 10 at 43. Beard teaches a particle size distribution by providing an average particle size (essentially Dv50) and a maximum size, and teaches why that size distribution is important to achieving Beard's pore structure.

248. Beard teaches a particle size distribution, not in the nomenclature of Dv10, Dv50, and Dv90, but instead by providing a D50 (average particle size) value (0.005, or between 0.001 and 0.1) and a maximum particle size value (0.1), as explained above in Paragraphs 200-201.

249. As I explained in my Preliminary Declaration, the possible ranges taught by Beard in Paragraph 22 "are extremely small by the standards of battery materials, namely 5-100 nanometers [0.005 – 0.1 μm] or 1-200 nanometers [0.001 –

0.2 μm] (for comparison, the wavelength of visible light is 400-750 nanometers [0.405 – 0.750 μm]).” Ex. 2015 ¶ 161. In this way, it would be clear to a POSITA that Beard is disclosing a very narrow, very small particle size distribution. This is simply another way for those skilled in the art to define the particle size distribution of particles in a porous layer. Where a distribution is very narrow, like in Beard, the method of giving only a range of average particle size diameter (0.001 – 0.1 μm , or 0.2 μm at most under Dr. Gido’s interpretation) and a maximum particle size (pore wall thickness, at most 0.1 μm) indicates to a POSITA that the exact Dv10 and Dv90 values are not important. What is important is that the average particle size is between these values and that the maximum particle size does not exceed the wall thickness. Thus, there would be no reason for a POSITA to search for a size distribution model provided specifically in terms of Dv10 and Dv90.

250. **Second**, even if a POSITA were to look for a size distribution in terms of Dv10, Dv50, and Dv90, they would not choose to use the particle sizes and distribution disclosed in Akiike because they are incompatible with Beard’s pore structure and goals. Petitioner argues (and the Institution Decision accepts) that a POSITA would look to Akiike because “[k]eeping D50 (Dv50) values above a floor of 0.5 μm and preferably above 0.7 μm also reduces the number of inorganic particles with ‘extremely small sizes,’ improving ‘battery properties such as high temperature cycle property.’” Paper 10 at 41 (quoting Pet. at 64 (citing Ex. 1011 ¶

32)). But this range in Akiike, 0.5 μm to 0.7 μm , is at least 0.3 μm **higher** than even what Dr. Gido agrees is the **ceiling** set by Beard for its average particle size and 0.4 μm higher than the maximum wall thickness (0.1 μm), which is also what Beard reports as the maximum particle size. Ex. 1010 ¶ [0022]. Even accepting Dr. Gido's broader understanding where the average particle could be as high as 0.2 microns, that means that Akiike requires half of its particles to be larger by at least 2.5 times the size of the **entire range** of average particle sizes Beard teaches. Ex. 1010 ¶ [0022].¹⁵

251. As explained above in Paragraphs 16-39, there are many different variables involved in creating a porous layer, and a POSITA would adjust the variables differently depending on what goals they have. While increasing the particle sizes outside of the range disclosed in Beard and broadening the size distribution like in Akiike may have some benefits for certain applications, by the same token it also has negative effects for other applications. In the context of Beard, a POSITA would have understood that changing the particle sizes and size

¹⁵ The broadest range disclosed in Beard is 0.001 μm to 0.2 μm . The span of this range is roughly 0.2 μm . Thus, Akiike's "floor" for Dv50 of 0.5 μm is 2.5 times the entire range of average particle sizes disclosed in Beard.

distribution so drastically would run counter to Beard's intended effect and would result in a different pore structure than in Beard's 100 embodiment (Fig. 1).

252. Beard performs a case study to determine “the most optimized pore structure along with high levels of filler loadings.” Ex. 1010 at [0085]. Beard teaches that its Cases 2 and 4 are the “most optimized” because they have “high levels of porosity” and create “the strongest possible filled polymer system.” *Id.* In other words, Beard is directed to optimizing pore structure, such that there is higher porosity and a densely packed (“strongest possible filled”) “polymer system.” *Id.* To achieve the “most optimized” structure of Beard, a POSITA would have been motivated to **avoid** larger particle sizes, like those disclosed in Akiike. This is because a POSITA would have recognized that the larger particles would be more likely to block pore pathways and would **decrease** porosity by filling up more previously empty space in Beard's porous layer.

253. In contrast to Beard, Akiike is focused on improving “high temperature cycle property” of its porous layer without unduly sacrificing heat resistance and mechanical strength for safety. A POSITA would have understood that Akiike was focused on optimizing its particle amount and sizes for increased heat resistance and mechanical strength. A POSITA would have been motivated to avoid the large amounts of binder taught in Beard (which are necessary to form Beard's structure) and increase the proportion of inorganic particles (which would decrease porosity,

one of Beard's primary goals). As Akiike teaches, high temperature cycling is dependent on adequate flow of ions through open pores, which in turn depends on avoiding small particles like the ones used in Beard (Akiike paragraph [0034]). On the other hand, Akiike teaches that heat resistance and mechanical strength for safety depend on dense packing of non-conductive (i.e. inorganic) particles, which in turn depend on avoiding too large of particles. (Akiike paragraph [0035]). A POSITA would understand that for strength and heat resistance that the binder is the "weak link" because polymers generally and substantially weaken at elevated temperatures compared to inorganic materials. Meanwhile, Akiike's unique and uncompromising use of particulate binder requires additional design considerations. The particulate binder has a characteristic size range that must be appropriately matched to the size range of the non-conductive particles in order to properly adhere adjacent particles to each other. Furthermore, achieving Akiike's dense packing of particles would be harmed by too narrow a distribution of particle sizes, as illustrated in Paragraph 30 above. Thus, a POSITA would understand from Akiike that a narrow distribution taught by Beard, and the small inorganic particle sizes taught by Beard, would simultaneously lead to poor safety performance and poor ion transport.

254. On the other hand, a POSITA would understand from Beard that Akiike's much larger and diverse particle sizes, coupled to particulate binder with its own characteristics, would not allow the open pore structure defined by narrow

pore walls that Beard seeks. Furthermore, a POSITA would have understood that using much larger inorganic particles (and such a broad range of particles) like in Akiike would mean that the particles are more likely to block the pores or otherwise negatively impact pore formation, thereby decreasing porosity. *See, e.g.*, Ex. 1010 ¶ [0086]. Thus, rather than turn to Akiike (which provides Dv10, Dv50, and Dv90 values that far exceed the provided size range in Beard), if a POSITA were looking to optimize Beard and retain its pore structure, but do so with a different size distribution, they would look for a reference that proposes Dv10, Dv50, and Dv90 values that already fall within Beard's guidelines (D50: 0.001 to 0.1 μm , maximum 0.1 μm) in order for its teachings to be applicable. A POSITA certainly wouldn't look to a reference like Akiike, where it is impossible to densely pack Beard's binder walls because at least half of Akiike's particles are between 0.5 μm to 0.7 μm —**5 times** the size of Beard's **maximum** wall thickness (0.1 μm), which Beard teaches should also be the **maximum** particle size. Ex. 2010 at [0021], [0028], Claims 1-20; Ex. 2033 at 71:15-22.

255. I understand that Petitioner and Dr. Gido separately rely on a statement in Beard about a “second optional embodiment” 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.” Ex. 1010 ¶

[0025]. This embodiment is *not* depicted in Fig. 1, which is the embodiment Petitioner and Dr. Gido rely on for arguing that Beard meets the claimed pore structure (as the Board has noted, Paper No. 10 at 33-34). The large particle size in this “second optional embodiment” would lead to pores that are 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. *See also* Ex. 2015 ¶¶ 131-134. Lastly, Beard’s larger fibrous particles would not be compatible with Akiike’s particulate binder particles, leading to failure of the combined design.

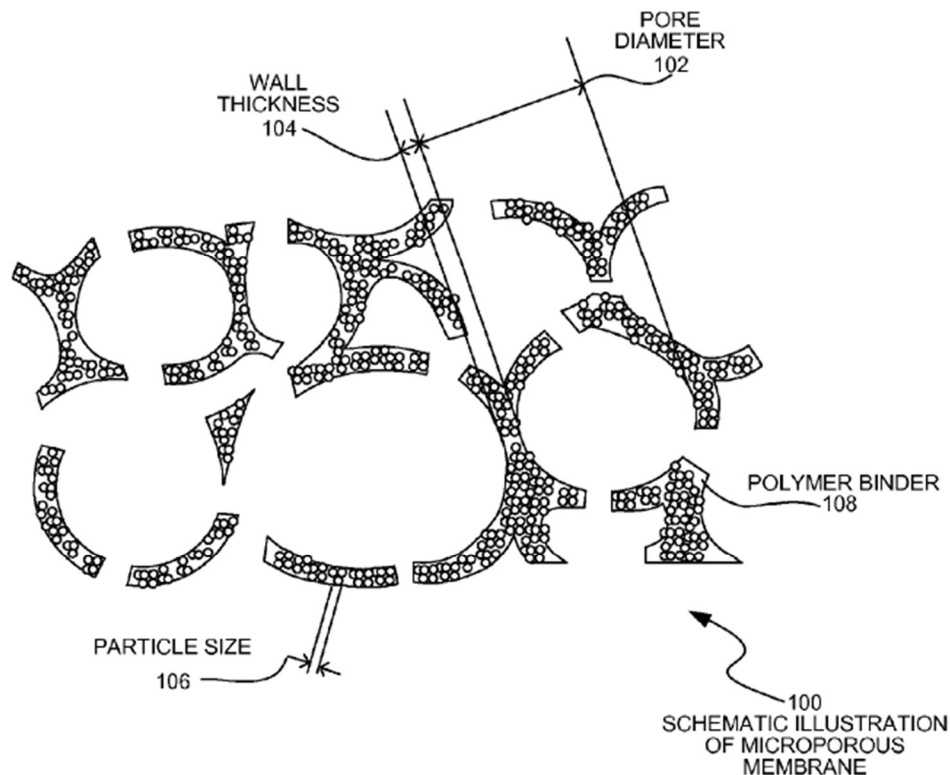
256. I understand that, in its Institution Decision, the Board found that Beard’s very small particle sizes are not key to Beard’s pore structure because “[t]he examples cited by Patent Owner either use the word ‘may’ or deal with a particular embodiment of Beard.” Paper No. 10 at 43. Respectfully, I disagree with this conclusion. Beard is a published patent application, and a POSITA reading its disclosure would have understood that its use of “may” is in the context of hoping to get the broadest patent possible. However, a POSITA would also have understood that the reported particle sizes and distribution in Beard were used for a reason. Just because there “may” be an infinite number of other particle sizes and distribution possibilities that exist does not mean that all those combinations would work with Beard’s pore structure. A POSITA would have understood Beard’s teachings about

the benefits of using “extremely small” particle sizes to mean that Beard’s reported particle sizes are the optimal particle sizes to achieve Beard’s pore structure. *See, e.g.,* Ex. 1010 ¶ [0064] (“In order to form a highly porous material, extremely small particles may be blended into a polymer melt or solvent solution with both a polymer and a liquid. During formation, the creation of pores and the bonding of the solids to the polymer can be carefully controlled for good results.”). Thus, even if a POSITA were motivated to find a reference with Dv10, Dv50, and Dv90 values so as to have a less uniform or more precise distribution, a POSITA would not have been motivated to throw away Beard’s minimum and maximum particle sizes entirely and adopt Akiike’s entirely different (and much bigger) particle sizes.

257. ***Third***, like with Murakami, a POSITA would not have been motivated to combine Akiike and Beard because they have fundamentally incompatible pore structures. This is because Akiike, like Murakami, teaches using larger inorganic particles, very little binder, and a process that results in a pore structure in Akiike that is similar to that of Murakami. This pore structure is entirely incompatible with that of Beard.

258. Beard’s pore structure (illustrated below in Fig. 1 of Beard) engulfs inorganic particles in the polymer binder. *See, e.g.,* Ex. 1010 ¶ [0026] (“The 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.”); [0030]

(“The membrane may be manufactured so that the fillers are dispersed within the wall structures . . .”); [0086] (“Good results may be achieved when the solid particles are contained exclusively or largely within the pore walls. . .”).



259. Akiike teaches that it is better to use an entirely different pore structure, one in which the binder does not capture or encompass the inorganic particles. In contrast to Beard, where the inorganic particles are “contained exclusively or largely within the [binder] pore walls,” the pores in Akiike are the “space[s] between the non-conductive particles.” Ex. 1011 ¶¶ [0094] (“[T]he space between the non-conductive particles in the porous membrane can be made large, and thus the

porosity of the porous membrane can be large.”); *see also id.* at ¶ [0150] (“In the porous membrane thus obtained, pores are formed in the space between the non-conductive particles. Thus the porous membrane has a porous structure.”).

260. Akiike teaches that the polymer (i.e. binder) “is 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 means that the binder in Akiike—as Dr. Guido recognizes—acts like “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, 245:3-16. Because the binder is in a “particulate shape,” it does not—and cannot—engulf the inorganic particles like in Beard.

261. Akiike’s porous layer would look similar to the illustration provided above for Murakami in Paragraphs 91 and 208. Ex. 2033 at 230:7-230:22 (“Well, I mean, this is basically the same thing as Murakami.”); 241:14-242:2.

262. Akiike teaches that its type of bonding—where the binder is minimal and just acts like sticky jellybeans holding the inorganic particles together only at specific contact areas (and not coating the particles)—is preferable because “the space between the non-conductive particles in the porous membrane can be made

large, and thus the porosity of the porous membrane can be large.” Ex. 1011 ¶ [0094].

263. As I discussed above in Paragraphs 198-211 and in Paragraphs 136-142 of my Preliminary Declaration, a POSITA would have recognized that Beard’s pore structure is dependent on at least (1) the very small particle sizes, and (2) the higher binder to inorganic particle ratio. If a POSITA were to substitute the much larger particle sizes in Akiike and/or use the very limited amount of binder suggested by Akiike,¹⁶ then the result would be Akiike’s—not Beard’s—pore structure. In other

¹⁶ As I explained in my Preliminary Declaration: “Beard discloses using at least 50% and as high as 200% by volume of binder compared to inorganic particles. Ex. 1010 ¶ [0029] (“In some embodiments, the volume of particles to polymer may be 1:1, 1:2, 2:1, 1:1.5, 1.5:1, or some other ratio.”). This is in contrast with Akiike, which discloses a much smaller amount of particulate polymer (which Akiike discloses “can function as a binder”): at least 0.1 parts by weight and no more than 10 parts by weight, “relative to 100 parts by weight of the non-conductive particles.” Ex. 1011 ¶ [0096]. Thus, Akiike discloses at least 0.1% and only as high as 10% by mass of binder compared to non-conductive particles.” Ex. 2015 ¶ 166. Moreover, as I explained above, all the examples in Akiike report using 6 parts by mass of

words, the pores would be “space[s] between the non-conductive particles.” *Id.* A POSITA would have recognized that they cannot pack Akiike’s larger particles into the structure of Beard because there are no binder pore walls in Akiike like there are in Beard. The POSITA would thus first need to adjust the particle sizes and binder ratio, among other variables, to make a structure with pore walls made of binder that the particles could be packed into. But, as Beard teaches, such a structure requires extremely small particles and much more binder than is used in Akiike, thus bringing the particle size distribution outside the claimed range.

264. More than that, however, a POSITA reviewing Beard and Akiike would not be motivated to adopt Beard’s pore structure but rather would use Akiike’s pore structure.¹⁷ Akiike explicitly teaches that its pore structure (pores that are gaps between particles, not pores formed by binder) is *preferable* to other pore structures,

particulate polymer compared to 100 parts of non-conductive particles. Ex. 2011 at Tables 1-5.

¹⁷ Akiike’s pore structure does not satisfy the pore structure elements of the claim, nor does Petitioner argue that it does. Akiike’s pores, which are formed by gaps between particles, are not “formed by the binder” in a similar way that Murakami’s are not.

such as that of Beard. For example, Akiike teaches that its “pores are formed in the space between the non-conductive particles” and “[t]hus the porous membrane has a porous structure.” Ex. 1011 at [0150]. Akiike then 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.* at [0151]-[0152]. Thus, a POSITA would have been motivated to use *Akiike’s* pore structure (pores that are gaps between particles and therefore are not “pores formed by the binder”) instead of Beard’s pore structure (pores delineated by binder pore walls). Dr. Guido recognizes that a POSITA would know that decreasing the relative amount of particles decreases the mechanical strength and decreases high temperature stability in the layer compared to a structure with relatively more binder. Ex. 2033 at 91:11-14, Ex. 2032 ¶ 53 (“the addition of inorganic particles improves both mechanical strength and high temperature stability”). To achieve Beard’s structure requires a relatively high amount of binder (between 33% and 67% by volume), and thus a POSITA would have understood that increasing the binder by that much would destroy Akiike’s goals of maintaining mechanical strength and high temperature stability.

265. **Finally**, even if a POSITA were to combine Beard and Akiike, there would be no reasonable expectation of success and in fact, the combination would not result in the claimed invention.

266. I understand that, in its Institution Decision, the Board preliminarily found that the combination of Beard and Akiike would result in the claimed invention because they agreed with Petitioner's argument that "the person of ordinary skill would retain the pore structure of Beard, but use the particle size distribution of Akiike." Paper No. 10 at 44.

267. Respectfully, I disagree that it is possible to retain the pore structure of Beard when using the much larger particles and much broader particle size distribution of Akiike. Akiike teaches that D10 is 0.2 μm to 0.4 μm , D50 is 0.5 μm to 0.9 μm , and D90 is 1.0 μm to 3.0 μm . Ex. 1011 at [0011]-[0013]. Not only does this mean that *all* the particle sizes in Akiike fall outside the broadest range provided in the preferred embodiment of Beard (0.001 to 0.2 μm), but it also means that most of the particles in Akiike are *significantly* larger than contemplated by Beard. Moreover, this size distribution in Akiike covers a much broader distribution (from 0.2 to 3.0 μm) than in Beard. To accommodate these much larger particles and much broader particle size distribution, while still maintaining the binder walls packed with inorganic particles like in Beard, a POSITA would have to increase Beard's binder wall thickness to encompass at least the biggest particles in Akiike (3 μm) and most likely more than that to accommodate places where the walls are more than one particle across. Not only is this an astronomical increase beyond the broadest wall thickness range disclosed in Beard (0.001 to 0.1 μm), but expanding the binder

wall thickness by that much would mean *decreasing* porosity because the previously empty spaces in Beard would be filled in with wide binder walls packed with large organic particles. It is unclear how such a combination could create a porous layer having sufficient porosity to meet Beard's porosity standards, let alone to be an acceptable porous layer for a functional battery separator.

268. Neither Dr. Guido nor the Petition explain how to make these changes to Beard's wall thickness to effectuate this combination. Moreover, if a POSITA were to expand the walls to the size of Akiike's particles (as is necessary to retain Beard's pore structure), then the resulting porous membrane would have walls that far exceed the claimed thickness of the '148 Patent. *See, e.g.*, Ex. 1001 at Claim 3 (requiring the average wall thickness between the pores to be in a range of 20 nm (0.02 μ m) to 500 nm (0.5 μ m)). This runs directly counter to the '148 Patent's teaching that a narrow wall thickness is a key benefit of the '148 Patent pore structure. *See, e.g.*, Ex. 1001 at 5:3-9 (“[S]ince the average wall thickness between adjacent pores in the porous film is low, the binder (typically a polymer, for example, polyvinylidene fluoride) can be prevented from swelling in the electrolyte and blocking the pores of the porous film after the porous film is subject to a soaking process in the electrolyte during the preparation of the lithium-ion battery.”); *see also id.* at 24:4-8 (explaining that where “the average wall thickness between the adjacent pores is large,” this

“seriously affects the cycle performance and rate performance of the lithium-ion battery”).

269. On the other hand, if a POSITA tried to use Akiike’s particle sizes without adjusting the thickness of the binder walls in Beard, then the resulting pore structure would be the one set forth in Akiike (not in Beard). In other words, as explained above, the pores would be gaps between the large inorganic particles like in Akiike. As explained throughout, this structure does not satisfy the claims of the ’148 Patent. Nor would a POSITA expect using Akiike’s large particle sizes to work with Beard’s thin binder walls, for the same reasons as discussed with Ground 4.

270. My arguments against a POSITA being motivated to combine Beard and Akiike may be summarized as follows. While both Beard and Akiike seek separators having porous pathways for facile transport of ions, this is not a distinguishing characteristic by itself, as this is an expectation of all battery separators. Thus, a POSITA must look to Beard’s and Akiike’s respective design goals and approaches, which in turn lead to real material constraints and incompatibilities. For a POSITA to attempt to combine Akiike with Beard in some way that meets in the middle or naively borrows from one or the other would disrupt the optimal balance each of Beard and Akiike claim to have achieved with their particle, binder, and pore configurations, and so would have no chance of success.

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

271. It is my understanding that in Ground 8, Petitioner asserts and Dr. Gido opines that Beard, Akiike, and Tanaka render obvious Claims 4 and 13. Pet. at 73-75; Ex. 1003 ¶¶ 236-41. These claims are reproduced above with respect to Ground 3.

272. These claims are not obvious for the same reasons noted above with respect to Independent Claims 1 and 10, and as set forth above with respect to Claims 3 and 6. Because, as Dr. Gido admits, Murakami and Akiike similarly have a high particle loading structure, a POSITA would have understood that all the same reasons for no motivation to combine and no reasonable expectation of success apply equally here. Ex. 2033 at 230:7-22, 241:14-242:2, 244:13-245:2.

273. A POSITA would not have been motivated to combine Tanaka with Beard and Akiike because Tanaka is focused primarily on using its porous layer in applications other than batteries. Tanaka is focused on improving water absorption performance through a porous sintered compact. Ex. 1009 at Abstract. As Dr. Gido admits, the main purpose of ensuring high water absorption performance in Tanaka is because “they want to use these things 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. A POSITA looking to improve a lithium-ion battery separator would not look to a reference primarily focused on improving water absorption performance for applications other than in batteries. There is no dispute that there is no water in a lithium-ion battery. Ex. 2033 at 266:18-267:7. There is also no dispute that Tanaka almost exclusively discusses applications other than for use in lithium-ion batteries. *Id.* at 265:14-266:9. The only place in Tanaka Dr. Gido identifies as discussing use in lithium-ion batteries is in Paragraph 69, which includes a laundry list of potential uses for a filter and does not provide any examples of how Tanaka's filter would work in a lithium-ion battery, let alone how effective it would be. Ex. 1009 ¶ [0069] ("The polyolefin porous sintered compact obtained by the present embodiment can be used as a general industrial member such as an adsorption immobilization transport sheet and the like, and can also be used in the life sciences field such as a support sheet for a rapid test kit by an immunochromatography method, a filter for apheresis treatment, a filter for artificial dialysis and the like, a pre-filter for various implants, a bioanalysis kit and the like, a carrier for a low-rigidity filter and the like, a carrier for an ion exchange resin and the like, and also in the electronics field such as an ink absorber for a printer head, a carrier for a solid electrolyte, a member for a fuel cell, a separator for a lithium ion secondary cell or a lead storage cell and the like.").

274. Achieving Tanaka's pore size distribution ratio would require altering the pore sizes in Beard to match Tanaka while still maintaining the particle sizes of Akiike. As explained above, pore sizes are necessarily affected by the particle sizes and particle size distribution used in the porous film. Ex. 2033 at 204:3-205:9. It would not be clear to a POSITA that they would be able to change Beard's pore sizes to achieve Tanaka's pore size distribution while maintaining Akiike's particle sizes and particle size distributions. Moreover, given the painstaking efforts by Beard to control pore creation and pore structure in its porous film, a POSITA would not be motivated to potentially alter Beard's pore structure and features by attempting to achieve Tanaka's pore sizes and pore size distribution coefficient, especially not based on a single line in Tanaka about the mere potential to use Tanaka's filter in a lithium-ion battery (with no examples or data as to how it performs in that context). Again, even Dr. Guido admitted during his deposition that Tanaka's porous substrate is less useful for use in a lithium-ion battery separator than in Honda, for example, because Honda "actually constructs batteries and you know tests them." Ex. 2033 at 268:17-269:4. In contrast, "Tanaka is mainly focused on more of these sort of filtration type applications." *Id.* Similarly, a POSITA would not be motivated to attempt Tanaka's pore sizes and pore size distribution coefficient at the risk of destroying the carefully balanced design disclosed in Beard, which actually constructs and tests batteries.

275. A POSITA further would not have been motivated to combine Tanaka with Beard and Akiike because Tanaka uses a sintered method, which is different than (and incompatible with) Beard and Akiike. As Dr. Guido explained in his deposition, “sintering is taking little particles of something like little grains of something and – bonding them together oftentimes maybe by heating them so that their outer surfaces kind of melt just enough to stick together,” or “compressing them even in the absence of heat, so that the outer layers kind of meld or merge into one another and they stick together.” Ex. 2033 at 265:5-13. This sintering process in Tanaka is applied to a polyolefin and does not involve any inorganic particles. Ex. 2033 at 266:1-9, 267:8-16. In contrast, both Beard and Akiike use inorganic particles. Given these extreme differences in chemical makeup between Tanaka, Beard, and Akiike, a POSITA would not expect the sintering process of Tanaka’s polyolefin to work with Beard’s composite layer that contains inorganic particles. Not only this, but the binder in Beard and Akiike hold the inorganic particles together, and so there is no need for sintering to “meld or merge” Beard or Akiike’s inorganic particles together.

276. Moreover, even if a POSITA were motivated to combine Tanaka with Beard and Akiike, a POSITA would not have reasonably expected to successfully arrive at the claimed invention. First, the Petition and Dr. Guido rely on Tanaka’s disclosure of pore size distribution coefficients in a polyolefin porous *substrate* to

disclose the same in a porous *film* (or layer). But the claims require the porous film to have the claimed pore size distribution coefficient—not the porous substrate. Neither Dr. Gido nor the Petition explain how a POSITA would be able to achieve the pore sizes and pore size distribution coefficient of Tanaka’s polyolefin porous substrate in Beard or Akiike’s composite porous films having inorganic particles. Second, neither Dr. Gido nor the Petition have explained how a POSITA would be able to accomplish Tanaka’s pore sizes and pore size distribution coefficient while retaining Akiike’s particle sizes and particle distribution. As Dr. Gido admitted in his deposition, 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 is dependent on the pore sizes in Tanaka. It is not clear how a POSITA could successfully imitate Tanaka’s pore sizes without altering the particle sizes and particle size distribution of Akiike, and neither Dr. Gido nor the Petition explain how that would work.

VIII. CONCLUSION

277. In sum, it is my opinion that Grounds 1-8 of the Petition do not render any of Claims 1-19 of the ’148 Patent unpatentable as obvious for the reasons I discuss above.

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on the information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code.

Executed on November 25, 2025, in Orem, Utah.

A handwritten signature in black ink, reading "Dean R. Wheeler", written over a horizontal line.

Dean R. Wheeler