

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

**DECLARATION OF DEAN R. WHEELER, Ph.D., IN SUPPORT
OF PATENT OWNER'S PRELIMINARY 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 have been asked, for purposes of Patent Owner’s Preliminary Response, to analyze and respond to particular assertions in the Petition and the evidence cited therein. I reserve the right to analyze and respond to other alleged patentability challenges if this proceeding is instituted.

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

6. 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

7. My qualifications and professional experience are described in my *curriculum vitae*, a copy of which is provided with this Declaration as Ex. 2002. The following is a brief summary of my qualifications and professional experience.

8. I am a university professor and consultant with 28 years of experience in the fields of electrochemical engineering, materials science, and manufacturing of battery materials. I received a B.S. in Chemical Engineering from Brigham Young University in 1996, and a Ph.D. in Chemical Engineering from the University of California, Berkeley, in 2002. My Ph.D. advisor was Professor John Newman, arguably the world's foremost leader in understanding battery materials through computer simulations. Under his direction, I acquired a deep understanding of the physics and chemistry of battery materials.

9. I have taught numerous classes on electrochemical engineering and materials science during my twenty-two years at Brigham Young University, as assistant professor, associate professor, and now, full professor. I currently serve as the department chair in the Chemical Engineering Department of Brigham Young University, supervising sixteen faculty members and six full-time staff.

10. I am an inventor on two issued patents and one patent application in the field of electrochemical devices. For example, U.S. Patent No. 11,340,261, issued in 2022, describes a flexible electric probe used to determine electrical properties of thin-film battery electrodes.

11. I have also authored or co-authored 63 peer-reviewed scientific publications. My most influential paper, “Quantifying tortuosity in porous Li-ion battery materials,” published in the Journal of Power Sources in 2009, has been cited more than 600 times, and describes the movement of ions through various types of battery materials, including separator and electrode materials. I have also published papers on the subjects of porous electrode structures and their formation, interactions of solids, binders, and electrolytes, interfaces between electrodes and electrolytes, and how all these factors relate to battery longevity.¹

¹ See, e.g., Exs. 2028 (Amir-Sina Hamed, Fezzeh Pouraghajan, Fei Sun, Mojdeh Nikpour, & Dean R. Wheeler, *Interplay of Electrode Heterogeneity and Lithium Plating*, 169 020551 J. Electrochem. Soc. (2022)), 2029 (Fei Sun and Dean R. Wheeler, *The Effects of Lithium Ions and pH on the Function of Polyacrylic Acid Binder for Silicon Anodes*, 170 080502 J. Electrochem. Soc. (2023)), 2030 (Fezzeh Pouraghajan, Andrea I. Thompson, Emilee E. Hunter, Brian Mazzeo, Jake

12. I have received more than \$7 million in government research grants to study batteries and related materials. Current research grants from NASA and the U.S. Army deal with understanding and improving electrolyte formulations and interactions between separators, anodes, and cathodes. My student assistants and I regularly fabricate and analyze battery materials in the laboratory, using techniques comparable to those described in the '148 Patent and cited prior art references. In particular, we routinely mix up custom-formulated electrolyte solutions, fabricate separators, anodes, and cathodes, and construct and test full lithium-based batteries. My research group is among the top users of electron microscopy at the university, which we use to analyze and understand battery electrode and separator structures. We also routinely measure the properties of battery materials and develop new diagnostic tools for making such measurements. Such training in my laboratory has allowed the students graduating from my program to go on to employment at

Christensen, Ram Subbaraman, Michael Wray, & Dean Wheeler, *The Effects of Cycling on Ionic and Electronic Conductivities of Li-ion Battery Electrodes*, 492 229636 J. of Power Sources (2021)), 2031 (Amir-Sina Hamed, Edmund M. Shumway, & Dean R. Wheeler, *Electrode-Level Modeling of Silicon Anodes for Improved Cell Design*, 171 120539 J. Electrochem. Soc. (2024)).

numerous battery manufacturers and battery-related startup companies across the United States.

13. In 2016, I led the Gordon Research Conference on Batteries,² as conference chair, having been nominated and voted into that position at a previous conference. This biennial international conference is attended by around two hundred of the world's thought leaders in the field of batteries. Furthermore, on three occasions I was selected to be a member of the technical review team for an ongoing \$25 million/year "Battery Hub" program funded by the U.S. Department of Energy.³ I believe my experience in such positions of leadership and responsibility, among others, reflects the stature with which I am viewed by my peers in the academic, industrial, and government battery research communities.

² See Ex. 2025 (*2016 Batteries Conference GRC*, <https://www.grc.org/batteries-conference/2016/> (last visited on May 12, 2025)).

³ See Ex. 2026 (*Hubs – Department of Energy*, <https://www.energy.gov/hubs> (last visited on May 12, 2025)); Ex. 2027 (*DOE Energy Innovation Hubs*, <https://science.osti.gov/bes/Research/DOE-Energy-Innovation-Hubs> (last visited on May 12, 2025)).

B. Materials Considered

14. 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, and any additional exhibits or other material cited in this Declaration.

15. 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.

16. 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

17. 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.

A. Claim Construction

18. My opinions concern what I believe the person of ordinary skill in the art ("POSITA") would have understood the meaning of certain claim terms to be based on the patent documents.

19. I have been informed that assessing the validity of a patent claim requires a two-step analysis. The first step involves the proper interpretation or construction of the claim language in order to determine its scope and meaning. The second step requires comparing the claim, as properly construed, to the alleged prior art to determine whether the limitations of the claim are met by the prior art.

20. My methodology for determining the meaning of claim phrases was first to study the patent carefully. In particular, I studied the claims themselves, followed by the background, detailed specification, figures, and other patent content. Next, I reviewed the prosecution history looking for any clarifications or limitations that might be attached to claim terms. In some circumstances, I looked at other documents, such as references applied by the patent office.

21. I understand that in an *inter partes* review, claim terms are to be given their ordinary and customary meaning as understood by a person of ordinary skill in the art in the context of the entire disclosure at the time of the invention. I understand that one must be careful not to read a specific embodiment appearing in the written description into the claim if the claim language is broader than the embodiment. I further understand that any special definition for a claim term must be set forth with reasonable clarity, deliberateness, and precision.

22. I have been informed that this standard is the same as that used in United States district courts, in which claim terms are given their ordinary and

customary meaning as would be understood by a person of ordinary skill in the art at the time of the invention having taken into consideration the language of the claims, the specification, and the prosecution history of record under the *Phillips* claim construction standard.

B. Prior Art Status

23. I understand that the “priority date” of a patent is the date on which it is filed, or the date on which an earlier-filed patent application is filed if the patentee claims the benefit of priority to that earlier-filed patent application. I understand that a particular claim is entitled to claim the priority date of an earlier-filed application if the earlier-filed application provides written description of the subject matter of that particular claim.

24. I understand that a U.S. or foreign patent or patent application qualifies as prior art to an asserted patent if the date of issuance or publication of the patent or publication is prior to the priority date of the challenged patent.

25. I understand that a printed publication, such as an article published in a magazine or trade publication, qualifies as prior art to the challenged patent if the date of publication is prior to the priority date of the asserted patent.

26. I understand that to qualify as prior art, a reference must contain an enabling disclosure that allows one of ordinary skill to practice the reference’s disclosure without undue experimentation.

C. Anticipation

27. I understand that, once the claims of a patent have been properly construed, determining anticipation of a patent claim requires a comparison of the properly construed claim language to the prior art on a limitation-by-limitation basis.

28. I understand that in order for a claim to be anticipated, each and every requirement of the claim must be found, expressly or inherently, in a single prior art reference as recited in the claim.

29. I understand that a prior art reference “inherently” discloses a limitation if that limitation is necessarily present in the prior art reference.

30. I understand, however, that inherency may not be established by probabilities or possibilities, and the mere fact that a certain thing may result from a given set of circumstances is not sufficient to establish anticipation by inherency.

31. I understand that it is impermissible for anticipation to combine multiple, separate embodiments, even if they are described in a single prior art reference.

32. Understanding that there are not any issues with respect to anticipation in this *inter partes* review, I focus my attention on obviousness.

D. Obviousness

33. I understand that a claimed invention is not patentable if the claimed invention would have been obvious to a person of ordinary skill in the field of the invention at the time of the patent claim's effective filing date.

34. I have been informed and understand that the obviousness analysis requires evaluating the claim language as a whole, including comparing each and every limitation of the properly construed claim language to the prior art.

35. I understand that a person of ordinary skill in the art provides a reference point from which the prior art and claimed invention should be viewed. This reference point prevents one from using his or her own insight or hindsight in deciding whether a claim is obvious.

36. I have been informed and understand that an invention composed of several elements is not proved obvious merely by demonstrating that each of its elements was independently known or in the prior art, but that there must be an apparent reason or motivation to combine the known elements in the fashion claimed by the patents at issue.

37. I understand that in order to show obviousness based on a single reference or a combination of references, a particular motivation to modify the reference or combine the teachings in the references, and a reasonable expectation of success must be shown. I further understand that whether a proposed modification

or combination of the prior art has a reasonable expectation of success is determined at the time the invention was made.

38. I understand that the obviousness inquiry includes consideration of various factors, such as the scope and content of the prior art, the differences between the prior art and the claims at issue, the knowledge of a person of ordinary skill in the pertinent art at the time of invention, and any objective factors indicating non-obviousness.

39. I am informed that objective factors indicating non-obviousness, also known as secondary considerations, may include (1) a long felt but unmet need in the prior art that was satisfied by the alleged invention of the patent; (2) commercial success or lack of commercial success of processes covered by the patent; (3) unexpected results achieved by the alleged invention; (4) praise of the alleged invention by others skilled in the art; (5) taking of licenses under the patent by others; and (6) deliberate copying of the alleged invention. I also understand that there must be a relationship or nexus between any such secondary indicia and the alleged invention.

40. I understand that in order to rely on a reference for obviousness, the reference must be analogous art. I also understand that to be analogous art, the reference must be either (1) from the same field of endeavor as the claimed subject matter, regardless of the problem addressed, or (2) if not in the same field of

endeavor, reasonably pertinent to the particular problem with which the inventor is involved. I am also familiar with the premise that for a reference to be reasonably pertinent, it must have logically commended itself to an inventor's attention at the time of invention.

IV. TECHNOLOGY OVERVIEW

A. Separators in Lithium-Ion Batteries

41. Lithium-ion batteries are commonly used in portable electronic devices like laptops and cellphones, as well as in electric vehicles. These types of batteries are known to have high energy density and good performance characteristics, including battery life.

42. Each lithium-ion battery has an anode, a cathode, an electrolyte, and a separator. When in a charging state, the lithium ions move from the cathode to the anode, where they are stored. When in a discharging state (i.e. when the battery is being used), the lithium ions move back to the cathode. That movement of lithium ions from the anode to the cathode releases energy that powers the device. The electrolyte is the solution in the battery that allows the lithium ions to move between the two electrodes.

43. A separator is a membrane placed between the cathode and the anode to prevent direct contact between electrodes, while still allowing lithium ions to pass through from one electrode to the other. Ex. 2028 at 99. Preventing contact between

electrodes is important, not only because contact between the cathode and anode can cause a short circuit, but because a short circuit could result in a fire or explosion. Given its safety function, the separator must be strong enough to withstand outside forces and high temperatures. *Id.*

44. At the same time, the separator must allow for high ion flow between the electrodes (i.e. high ionic conductivity) and must not react to the electrolyte solution in a way that negatively affects ionic conductivity or other requirements of successful battery operation. *Id.*

45. The various design considerations for separators require an extremely delicate balance of elements in the composition of the separator and its components. Experts in the field have been working on that balance for decades.

46. One workable design for a separator involves using a porous substrate, on its own, as the separator. *Id.* The most common material is a polyolefin such as polypropylene or polyethylene. *Id.*

47. Another 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. 1005 ¶¶ [0004]-[0005]. This porous layer may be made up of many types of materials, including different types of resins, organic particles, and/or inorganic particles. *Id.*; *see also id.* ¶ [0060].

48. Regardless of the separator chosen, one problem in the prior art was that a gap would be created between the electrode and the separator during the cycle process (i.e. by charging and discharging the battery). Ex. 1001 at 1:29-37. This gap between the separator and the electrode reduces the cycle capacity of the lithium-ion battery and thus shortens the battery's service life. *Id.*

B. The '148 Patent

49. The '148 Patent recognized this problem and identified “an urgent need for a technical solution to solve the problem of the gap issue between the separator and the electrode so as to improve the service life of the lithium-ion battery.” Ex. 1001 at 1:29-37. In response, the '148 Patent describes and claims a novel porous film that solves this problem while still allowing for high ionic conductivity.

50. For example, the '148 Patent explains: “The porous film provided by the application has excellent adhesion, and meanwhile the pore structure of the porous film can still be well maintained after being immersed in the electrolyte, thereby reducing the probability of pore blockage of the porous film and enabling the porous film to have high ionic conductivity.” *Id.* at 2:47-52. In this way, “the rate performance of the lithium-ion battery is greatly improved, and the provided lithium-ion battery has excellent rate performance and cycle performance.” *Id.* at 2:52-56.

51. The '148 Patent describes both the composition and the structure of the pores in its porous film. For example, the patent explains that the porous film

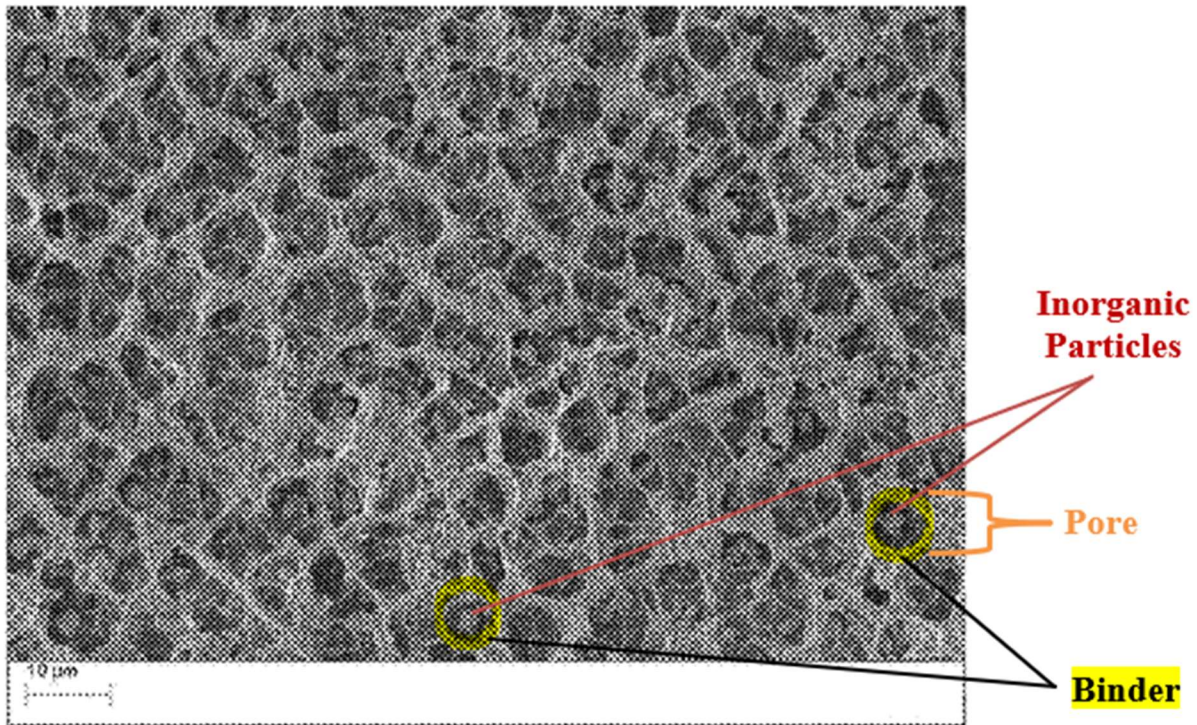
includes “a binder and inorganic particles of different particle sizes,” wherein “the inorganic particles are fixed by the binder.” *Id.* at 3:17-19.

52. According to the '148 Patent, because “the porous film includes the binder, the porous film has good adhesion, which can prevent the porous film from detaching during use of the lithium-ion battery, and enables the lithium-ion battery to have a high safety performance.” *Id.* at 3:20-24. In addition, the binder ensures that “the average pore size of the porous film is larger and the pore sizes are distributed uniformly, so that the porous film has good electrolyte diffusion and absorption capability and high ionic conductivity, the polarization reaction inside the lithium-ion battery can be reduced, thereby improving the rate performance of the lithium-ion battery.” *Id.* at 3:24-30.

53. The '148 Patent describes the importance of using enough binder to gain sufficient adhesion between the porous film and adjacent layers, while not using so much that it results in pores inadequate for transporting ions. *Id.* at 5:50-60. It states that “the volume ratio of the inorganic particles to the binder in the porous film is in a range of 0.2 to 3.0.” *Id.* at 5:50-52. According to the patent, “[i]f the volume ratio of [inorganic particles to binder] is lower than 0.2, the average pore size of the porous film is reduced, the porosity is decreased, and the rate performance of the lithium-ion battery is deteriorated drastically.” *Id.* at 5:52-55. But on the other hand, “[i]f the volume ratio of [inorganic particles to binder] is greater than 3.0, the

adhesive force of the porous film is reduced,” and “[w]hen the porous film is applied to a lithium-ion battery, the porous film tends to fall off due to poor adhesion, resulting in deteriorated safety performance of the lithium-ion battery.” *Id.* at 5:55-60.

54. The patent also provides scanning electron microscope (SEM) images of the porous film used in the claimed invention so that a POSITA can see how the pores are formed. Consistent with the patent’s description of the volume ratio of inorganic particles to binder, the SEM images show pores formed by the binder, where at least a portion of some of the inorganic particles are within the pore. I have annotated Figure 1 below to show this.



55. Figure 2 (below) is a zoomed-in image and shows the pores formed by the binder, with at least a part of the inorganic particles within the pores.

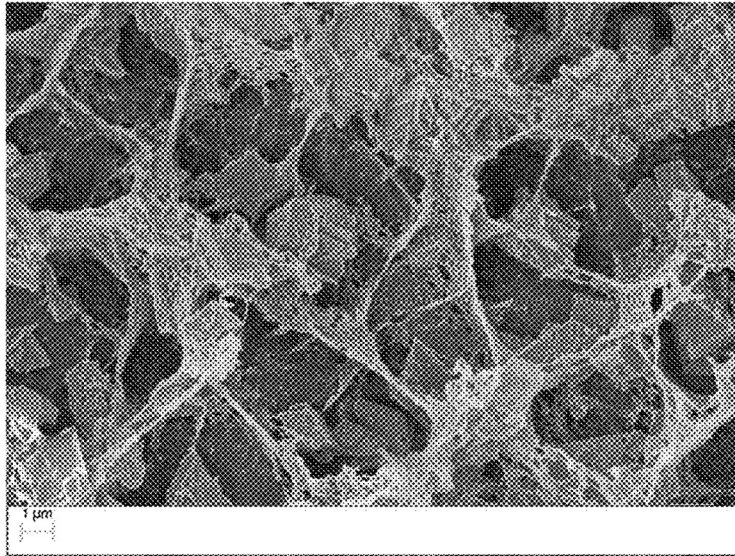


FIG. 2

56. The '148 Patent further describes the process by which the porous film is made. It explains a method for preparing a porous film that includes the following steps:

- (1) mixing inorganic particles with a binder, and then adding a first solvent and uniformly stirring the mixture to obtain a coating solution, wherein the binder is dissolved in the first solvent;
- (2) uniformly coating the coating solution on at least one surface of a substrate to form a wet film;
- (3) immersing the substrate with the wet film into a coagulation solution for phase transformation, wherein the coagulation solution includes a second solvent and a third solvent, and the second solvent and the third solvent are miscible with each other;
- (4) performing a drying process after the phase transformation is completed, to obtain the substrate whose surface is provided with a porous film, wherein the average wall thickness between adjacent

pores in the porous film is in a range of 20 nm to 500 nm, and the average pore size of the porous film is not less than 0.3 μm .

Id. at 5:61-6:13. This process involves “the principle of phase transformation (i.e., non-solvent induced phase separation, NIPS).” *Id.* at 6:16-19.

57. The '148 Patent explains its use of NIPS as follows: “In the coating solution obtained in the step (1), the first solvent is oily, and the binder (for example, polyvinylidene fluoride) may be dissolved in the first solvent.” *Id.* at 6:19-21. “The third solvent contained in the coagulation solution in step (3) is one or more selected from deionized water, ethanol, propanol, acetone, dimethyl carbonate and diethyl carbonate, and the binder is insoluble in the third solvent (for example, deionized water).” *Id.* at 6:21-26. Thus, “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.” *Id.* at 6:26-32.

58. In other words, a POSITA would have understood that the binder in the '148 Patent is dissolved in the first solvent, but upon application of the coagulation solution, the binder forms its own solid phase with interconnected threads like a spider web, forming the pores. Meanwhile the inorganic particles which were

distributed in the solvent-and-binder mixture become immobilized in the newly formed solid binder phase.

59. As for the inorganic particles, the '148 Patent describes specific size distributions that should be achieved for peak performance. To describe the size distributions of the inorganic particles, the '148 Patent uses Dv10, Dv50, and Dv90. The patent explains that “[t]he particle size (Dv10) having a volume accumulation of 10% refers to particle sizes which reach 10% of the cumulative volume from the side of small particle size in the granularity distribution on a volume basis,” whereas “[t]he particle size (Dv50) having a volume accumulation of 50% refers to particle sizes which reach 50% of the cumulative volume from the side of small particle size in the granularity distribution on a volume basis,” and “[t]he particle size (Dv90) having a volume accumulation of 90% refers to particle sizes which reach 90% of the cumulative volume from the side of small particle size in the granularity distribution on a volume basis.” *Id.* at 4:6-18.

60. In other words, to produce a particle size volume distribution in the '148 Patent, particles are first characterized and then ordered by their volume (i.e. a “granularity distribution on a volume basis”), meaning the volume of each particle is measured and then the particles are ranked from smallest to largest according to each particle’s volume. Then the total volume of particles is determined for the subset comprising all particles smaller than a certain size (i.e. “cumulative volume

from the side of small particle size”). Then this volume of a subset of the particles is normalized into a volume percentile by dividing by the total volume of all particles of all sizes. By this method a normalized volume distribution or function is produced in which a number between 0 and 100 % of the cumulative volume is produced for a particular particle size that is within the range of all possible particle size values, where 0 represents the smallest possible particle and 100% represents the largest possible particle. This ranking of particle volumes is similar in principle to the percentiles that are used to rank student performance on standardized tests.

61. Particle sizes in this distribution are typically given in terms of an *effective diameter*. I use the term effective diameter because no particle is a perfect sphere having a single diameter. In fact, particles can come in any variety of shapes. Nevertheless, one commonly takes the effective diameter of a particle to be the diameter of a sphere that has the same volume as the measured volume of the particle in question. So even if a particle has, for instance, a shape more like a cube or a cylinder, it can be represented volumetrically as if it were a sphere of a certain diameter.

62. With these principles in mind, we get to the meanings a POSITA would understand for Dv10, Dv50 and Dv90. These values are intended to take a variety of particle shapes and sizes and boil it down to three representative numbers. The Dv10 value represents the particle size for which all particles of equal or smaller size

occupy 10% of the cumulative volume occupied by all particles. Dv50 and Dv90 likewise represent distinct particle sizes in the distribution of all particles, albeit at the 50% and 90% cumulative volume levels respectively. The comparative Dv10, Dv50, and Dv90 values tell the POSITA something about the width or narrowness of the particle size distribution, that is, if all particles were of the same volume then the distribution is infinitely narrow and $Dv10 = Dv50 = Dv90$. And if the particles being sampled have a large range of sizes, then the distribution is wide and a POSITA would expect notable differences in the respective values of Dv10, Dv50, and Dv90.

63. The '148 Patent states: “[t]he particle sizes of the inorganic particles satisfy that the particle size having a volume accumulation of 10% (Dv10) is in a range of 0.015 μm to 3 μm , the particle size having a volume accumulation of 50% (Dv50) is in a range of 0.2 μm to 5 μm , and the particle size having a volume accumulation of 90% (Dv90) is in a range of 1 μm to 10 μm .” *Id.* at 4:1-6.

64. It teaches that this size distribution is key: “the inorganic particles having large particle sizes and a narrow peak distribution are used, therefore the exchange speed between the non-solvent (third solvent) in the coagulation solution and the organic solvent (first solvent) in the coating solution can be increased during the formation of the porous film, and a porous film structure with a larger average pore size and smaller average wall thickness between the adjacent pores is formed.”

Id. at 4:18-25. According to the '148 Patent, “[w]ithin this range, if the particle sizes of the inorganic particles become smaller, the exchange speed between the non-solvent (third solvent) in the coagulation solution and the organic solvent (first solvent) in the coating solution is decreased during the formation of the porous film, the development of the pore structure is slower, the average pore size of the formed pore is decreased, and the average wall thickness between adjacent pores is increased.” *Id.* at 4:25-33. On the other hand, “if the particle sizes of the inorganic particles become larger, the exchange speed between the non-solvent (third solvent) in the coagulation solution and the organic solvent (first solvent) in the coating solution is increased, the development of the pore structure is faster, the average pore size of the formed pore is increased, and the average wall thickness between adjacent pores is decreased.” *Id.* at 4:33-40. Moreover, “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.” *Id.* at 4:40-45. By the same token, “[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.

65. In addition to specifying particle size distributions for the inorganic particles, the '148 Patent also describes a specific ratio of Dv90 to Dv10 that is critical for the claimed invention: $Dv90/Dv10 = 2 \text{ to } 100$. *Id.* at 4:54-56. According to the '148 Patent, “[i]f Dv90/Dv10 is greater than 100” then this “will lead to the particle size distribution of the inorganic particles being too wide, the uniformity of the formed pores is poor, and polarization reactions will easily occur in the lithium-ion battery.” *Id.* at 4:56-60.

66. The '148 Patent also explains that Dv10 should be smaller than Dv50, which should be smaller than Dv90. *Id.* at 2:4-9.

V. LEVEL OF ORDINARY SKILL IN THE ART

67. I understand that Petitioner provides the following definition of a POSITA:

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

Pet. at 14.

68. For purposes of this Declaration in support of Patent Owner’s Preliminary Response, I offer no independent opinion of the level of ordinary skill in the art but have adopted the definition proposed by Petitioner. I reserve the right to further address the level of ordinary skill in the art if this proceeding is instituted.

69. Each of the arguments below should be considered from the perspective of a POSITA in the field of the ’148 Patent and during the relevant time frame (e.g., June 2018). During that time frame, I possessed at least the qualifications of a POSITA, as defined above.

VI. CLAIM CONSTRUCTION

70. I understand that neither the Petition nor Dr. Guido set forth any express constructions for any claim terms. For the purposes of this declaration, I apply the plain and ordinary meaning of all claim terms from the perspective of a POSITA. I reserve the right to put forth opinions regarding claim construction if trial is instituted.

VII. THE BOARD SHOULD NOT INSTITUTE INTER PARTES REVIEW

71. I understand that in order for an *inter partes* review to be instituted, the Petition must establish that there is a reasonable likelihood that at least one challenged claim is unpatentable. For at least the reasons I explain below, it is my opinion that the Petition fails to do so.

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

72. It is my understanding that in Ground 1, Petitioner contends and Dr. Guido 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. These claims recite:

1. A porous film, comprising:
a binder; and
inorganic particles;
wherein the porous film comprises pores formed by the binder, the pores at least comprises a part of the inorganic particles, 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; Dv10 of the inorganic particles is less than Dv50 of the inorganic particles, and Dv50 of the inorganic particles is less than Dv90 of the inorganic particles, and the inorganic particles have particle sizes that the ratio of Dv90 to Dv10 is in a range of 2 to 100.

2. The porous film according to claim 1, wherein the porous film has an average pore size of 0.3 μm to 20 μm.

5. The porous film according to claim 1, wherein the inorganic particles are at least one selected from the group consisting of alumina, silica, magnesia, titanium oxide, hafnium dioxide, tin oxide, cerium dioxide, nickel oxide, zirconia, zinc oxide, calcium oxide, boehmite, aluminum hydroxide, magnesium hydroxide, calcium hydroxide, and barium sulfate.

6. The porous film according to claim 1, wherein the binder is at least one selected from the group consisting of polyvinylidene fluoride, vinylidene fluoride-hexafluoropropylene copolymer, polyamide, polyacrylonitrile, polyacrylate, polyacrylic acid, polyacrylic acid salt, sodium carboxymethylcellulose, polyvinylpyrrolidone, polyvinyl ether, polymethyl methacrylate, polytetrafluoroethylene and polyhexafluoropropylene.

7. The porous film according to claim 1, wherein the porous film has a porosity of 20% to 90%.

8. The porous film according to claim 1, wherein the porous film has a thickness of 0.2 to 10 μm .

9. The porous film according to claim 1, wherein a volume ratio of the inorganic particles to the binder is in a range of 0.2 to 3.0.

10. A lithium-ion battery, comprising:

a positive electrode;

a negative electrode;

a separator, arranged between the positive electrode and the negative electrode;

non-aqueous electrolyte; and

a porous film, comprising:

a binder; and

inorganic particles;

wherein the porous film comprises pores formed by the binder,

the pores at least comprises a part of the inorganic particles,

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 , Dv90 is in a range of 1 μm to 10 μm ; Dv10 of the inorganic

particles is less than Dv50 of the inorganic particles, and Dv50

of the inorganic particles is less than Dv90 of the inorganic

particles; and the inorganic particles have particle sizes that the ratio of Dv90 to Dv10 is in a range of 2 to 100.

11. The lithium-ion battery according to claim 10, wherein the porous film has an average pore size of 0.3 μm to 20 μm .

14. The lithium-ion battery according to claim 10, wherein the inorganic particles are at least one selected from the group consisting of alumina, silica, magnesia, titanium oxide, hafnium dioxide, tin oxide, cerium dioxide, nickel oxide, zirconia, zinc oxide, calcium oxide, boehmite, aluminum hydroxide, magnesium hydroxide, calcium hydroxide, and barium sulfate.

15. The lithium-ion battery according to claim 10, wherein the binder is at least one selected from the group consisting of polyvinylidene fluoride, vinylidene fluoride-hexafluoropropylene copolymer, polyamide, polyacrylonitrile, polyacrylate, polyacrylic acid, polyacrylic acid salt, sodium carboxymethylcellulose, polyvinylpyrrolidone, polyvinyl ether, polymethyl methacrylate, polytetrafluoroethylene and polyhexafluoropropylene.

16. The lithium-ion battery according to claim 10, wherein the porous film has a porosity of 20% to 90%.

17. The lithium-ion battery according to claim 10, wherein the porous film has a thickness of 0.2 to 10 μm .

18. The lithium-ion battery according to claim 10, wherein a volume ratio of the inorganic particles to the binder is in a range of 0.2 to 3.0.

19. The lithium-ion battery according to claim 10, wherein the porous film is arranged on a surface of at least one selected from the group consisting of the positive electrode, the negative electrode and the separator.

73. I disagree that any of Claims 1-19 are obvious over Murakami for the reasons discussed below.

74. The '148 Patent and Murakami are directed to two very different problems. Murakami is not directed to the problem solved by the '148 Patent—filling a gap that forms between the separator and electrode during the life cycle of a battery. Rather, Murakami is directed to improving the cycle characteristics of a battery by minimizing variability in voidage throughout a porous layer. Ex. 1005 at Abstract (describing that when the “porous layer is divided into 32 sections, a degree of variability in voidage that is measured in the 32 sections is 16.0% or lower”). Murakami’s stated reason for focusing on consistency in voidage throughout the porous layer is that “in a case where a degree of variability of the voidage is controlled within a predetermined range, a non-aqueous electrolyte secondary battery, which includes a separator that is a laminated body in which the porous layer is laminated onto one surface or each of both surfaces of the porous film, has an

excellent cycle characteristic.” *Id.* ¶ [0013]. Murakami defines “an excellent cycle characteristic” as an instance in which a battery “can substantially retain an initial discharge capacity even after a charge-discharge cycle is repeated.” *Id.* ¶ [0012].

75. 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. I disagree.

76. Murakami fails to disclose or render obvious the claimed invention for at least the following reasons.

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

77. Dr. Gido 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])); and (2) “Murakami forms those pores through a process like that described in the ’148 Patent” (Ex. 1003 ¶ 94). I disagree.

a. Dr. Gido Does Not Explain the Plain Meaning of “Pores Formed By a Binder”

78. Dr. Gido does not explain the plain and ordinary meaning of “pores formed by the binder.” A POSITA would have understood the plain and ordinary meaning of this phrase to require that the pore geometry is itself defined by the boundaries of the binder. The addition of the words “formed by the binder” in the

claims indicates to the POSITA that the binder itself is the boundary that defines the structure of the pores and, thereby, “forms” the pores.

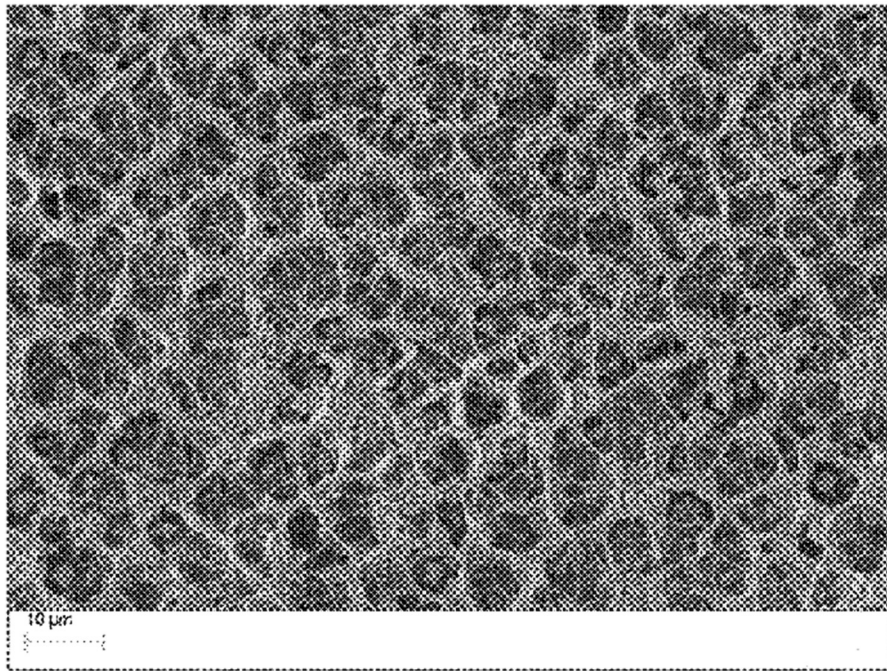
79. This meaning is supported by the specification. The '148 Patent states that “the binder in the coating solution is coagulated and separated out, thus forming a porous film.” Ex. 1001 at 6:26-32. In other words, as explained above in Paragraphs 56-58, a POSITA would have understood this to mean that 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.

80. The specification further explains that “the volume ratio of the inorganic particles to the binder in the porous film is in a range of 0.2 to 3.0” *Id.* at 5:50-52. In other words, there is anywhere from 25 vol% to 83 vol% binder in the solid portion of the porous layer comprised of binder and inorganic particles.⁴ If there is more than 83 vol% binder in the solid, “the average pore size of the porous

⁴ 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.

film is reduced, the porosity is decreased, and the rate performance of the lithium-ion battery is deteriorated drastically.” *Id.* at 5:52-55. 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.

81. The ’148 Patent confirms this meaning by providing SEM images of its porous film that show the pores are formed by the binder. In the SEM image below, for example, the white material forming a matrix or network is the binder. You can see that the empty space (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.



82. Thus, 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.

b. Murakami Does Not Provide Any Images Showing the Binder Defines the Structure of the Pores

83. I disagree with Dr. Guido’s implication that a POSITA would be able to assume, based on the disclosure of Murakami, that Murakami’s pores were formed by the binder. Murakami does not provide any disclosure regarding the formation of its porous layer, which is not surprising given that the focus of Murakami is on minimizing variability in total voidage throughout a porous layer. Murakami also does not provide any images of the porous layer by which a POSITA would be able

to determine the pore structure, let alone how they are formed, including whether they are formed by Murakami's binder.

84. A POSITA would have understood that imaging, to include SEM imaging, would be required to determine pore structure and composition with any level of reliability. This is the case for the '148 Patent, as explained above.

85. While Murakami references SEM images (Ex. 1005 ¶ [0095]), it never provides those images or explains what they show in terms of pore structure. Instead, the Murakami description focuses solely on determining the overall voidage (i.e. percentage of empty space) of different slices of the layer, without any description as to how any voids or pores are actually formed and what material(s) form the boundaries of any pores or voids. *Id.* Even though voidage or porosity for porous layers is commonly given by practitioners in the battery field, it is not sufficient for a full description of pore structure and composition. In other words, because pores potentially comprise a complex distribution of sizes, shapes, and materials, a single metric like voidage would not contain enough information to describe them. To wit, Murakami does not disclose any images, or even a description of the images, from which a POSITA could deduce that Murakami's pores are formed by the binder, as opposed to Murakami's particles.

c. If anything, Murakami Discloses that Its Pores Are Formed by the Inorganic Particles, Not the Binder

86. Even if a POSITA could tell with any level of reliability how Murakami's pores are formed without being provided with an image, a POSITA would have determined that the pores in Murakami's porous layer are *not* formed by the binder but instead are formed by Murakami's inorganic particles.

(i) Murakami Teaches Away from Forming Pores Using a Binder Because It Teaches that Its Filler Should Not Be Dispersed in a Binder

87. The first clue that the pores are not formed by the binder in Murakami is Paragraph 70 of Murakami, which reads

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.

The POSITA would have understood that the purpose of the binder resin according to 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. That is, the amount of binder resin provided by Murakami is minimal and is just enough to bind the filler together—meaning that the boundaries of any pores in Murakami are formed by the filler, and not by the binder as the claims of the '148 Patent require. Moreover, Paragraph 70 of Murakami teaches that the filler should not be **dispersed** in the binder resin.

Dispersing the filler in the binder resin would imply that the filler is mostly or fully encapsulated or coated by binder resin. Therefore, avoiding this unsuitable situation according to Murakami would require that the amount of binder resin should be greatly circumscribed.

(ii) Murakami Teaches that the Pores Are Formed By the Inorganic Particles, Not the Binder

88. Paragraph 69 of Murakami further teaches that the pores are formed by “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.

This teaches that one of the goals of Murakami is to ensure that gaps between filler particles (and contact between filler particles) are not blocked by binder resin, teaching to a POSITA that the filler particles are not themselves coated in resin—that is, the filler particles are themselves in contact with each other, and *the gaps in Murakami are formed by contact of particles of the filler*—not by the binder. This understanding is confirmed by the fact that Murakami teaches using only a minimal

amount of binder. Murakami teaches that the smaller the fraction of binder compared to filler, to *as little as 1 mass % binder* (that is, 99 mass % filler), the better and more preferable the outcome:

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.

89. A POSITA would understand that using such a minimal amount of binder in the porous layer would not result in the pores in Murakami being formed by the binder. Instead, a POSITA would understand that the pores in Murakami's porous layer would be defined by the boundaries of the filler, and not the binder. Moreover, Murakami elsewhere teaches in Examples 1 and 2 that 3 parts by weight binder compared to 100 parts by weight of filler is advantageous in the porous layer. *Id.* ¶¶ 141 and 161. Indeed, even Dr. Gido admits that “the porous layer consists of *nearly all filler material* and *relatively little [binder] resin* by weight.” Ex. 1003 ¶ 103. Dr. Gido does not provide any sufficient justification for how so little binder could nonetheless form the pores in Murakami—because it could not. A POSITA would have understood that there would need to be enough binder in the porous layer

to surround the empty spaces in order for it to form the pores, such as the 25 to 83 solid volume percent of binder in the porous layer disclosed in the '148 Patent.

90. While Dr. Guido cites Murakami's disclosure that "the filler is bound by the binder resin," it is my opinion that he misinterprets the meaning of that phrase and contradicts the remainder of Murakami Paragraphs 69 and 70 discussed above. In contrast to Dr. Guido's interpretation, a POSITA would understand that Murakami explains what it means by "the filler is bound by the binder resin" when it states that "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." *Id.* Combined with Murakami's teaching about preferably decreasing and minimizing binder resin to as low as 1 mass %, and explaining that the filler particles are in contact with each other and that the particles are what form the "gaps" in Murakami, a POSITA would understand Murakami to teach that the role of the binder is limited simply to attaching the filler particles together at some points of particle contact, because that is the only function such a small fraction of binder resin that does not envelop the filler could accomplish. Because Murakami teaches that dispersing the filler in a binder resin is *not suitable* for its porous layer, and that the gaps in Murakami are formed by the filler particles, a POSITA would understand that the binder resin would not form the boundaries of Murakami's pores.

91. Indeed, a POSITA would have understood that when using such a minimal amount of binder resin and a great deal of filler (most preferable 90 mass% and up to 99 mass%), Murakami teaches that its binder resin would thus be present between the filler particles so as to attach them to one another, not fully coating those particles. As a result, a POSITA would characterize the binder as essentially little dots of glue that hold together the inorganic filler particles. Given the total amount of binder and the behavior of the binder to bind the particles, a POSITA would have understood that there simply was not enough binder present in the porous layer of Murakami for the binder to be the component that forms the pores. Rather, any pores or gaps that were formed in Murakami, would be formed by the particles themselves because the particles—and not the binder—would define the boundaries of Murakami’s pores or “gaps.”

92. Thus, while a POSITA would be unable to know the pore structure of Murakami for sure without looking at SEM images, if anything, a POSITA would understand from Murakami’s disclosures that the pores in Murakami’s layers are formed solely by the gaps in between inorganic particles. Thus, the pores would be formed by the inorganic filler particles—not the binder. This is a logical consequence and wholly consistent with Murakami’s disclosure in Paragraphs 69 and 70, because if there is not sufficient binder to form the pores or to disperse the filler particles and thereby encapsulate them, then the pores or gaps in Murakami

must be formed by the only other solid present in the porous layer, namely the inorganic filler particles. This is consistent with how Murakami explains that its gaps are “*formed by contacts of particles in the filler.*” *Id.* ¶ 69.

d. Murakami’s Process of Making the Porous Layer Does Not Create “Pores Formed by the Binder”

93. The ’148 Patent discloses that “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.” *Id.* at 6:26-32. Coagulating the binder and separating it out to “form[] a porous film” is taught nowhere in Murakami and, thus, this further confirms to a POSITA that Murakami does not teach or suggest “pores formed by the binder.”

94. Instead, Murakami teaches creating a basic solvent mixture containing a small amount of binder and large amount of inorganic particles, dispersing the alumina (inorganic particle) dispersion by high pressure, applying that coating layer to a different porous layer that was subjected to corona treatment, and letting the coating film dry. *Id.* ¶ [0143]. A POSITA would have understood that the Murakami process does not use a “third solvent,” such as the third solvent disclosed in the ’148

Patent, such that the binder coagulates and separates out of solution to form the pores.

95. Murakami's method of forming a porous layer would have a very different effect than the method of the '148 Patent. While drying of the porous film is a final step in its formation in both the '148 Patent and Murakami methods, in the '148 Patent method the binder has already been coagulated, which means it has formed into a separate and stable solid phase from the liquid mixture in which it originated. On the other hand, in Murakami's method, the binder is brought out of the liquid and becomes a solid phase in a sequential manner as the liquid retreats during the drying step. This change has enormous implications on the respective microstructures and organizations of the resulting pores of the two methods. For instance, in the '148 Patent, the solid is formed by coagulation, meaning the solid is formed out of the liquid while being mechanically stabilized by the liquid matrix throughout the pore formation process, and liquid is present in the pores throughout the process. On the other hand, in Murakami, as the liquid is removed by evaporation, it leaves behind a non-evaporating solid that was previously dissolved in the liquid. The pores, such as they are, are instead filled with vapor (the evaporated liquid) and are prone to have different morphology than the coagulation process. There is thus in Murakami a three-phase interface at the location where the pores are being formed, namely solid, liquid, and vapor. It would be obvious to a POSITA that

pores that are formed at the interface of solid, liquid, and vapor (e.g. in Murakami) would necessarily be different than pores formed at the interface of only solid and liquid (e.g. '148 Patent) due to substantially different interfacial interactions.

96. 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”

97. 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 layers 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 disagree that this means Murakami discloses this element.

98. To be a part of the pore itself, an inorganic particle must extend into the empty space delineated by the boundary of the binder. The claims require that the “*pores . . . at least **comprise** part of the inorganic particles.*” The claim has two requirements that must be met at the same time. First, the pore must still be “formed by the binder” and second, the pore must “at least comprise a part of the inorganic particle.” The natural reading of these two requirements in conjunction is that the binder primarily defines the pore walls and shape, defining the geometry of the

empty spaces or gaps, and the inorganic particles extend partially into those empty spaces (the pores). That is, a POSITA would have understood the claim language to require that the inorganic particles be part of the pores themselves (i.e. the empty space) and not merely the walls that surround the pores. This is due to the fact that a POSITA would have understood that the recited “pore” refers to an empty space divided from another empty space by a wall (i.e. “pore wall”).

99. As explained above, the fact that Murakami teaches using predominantly inorganic filler and very little binder means that the pores in Murakami are formed by the gaps between the inorganic particles. In other words, the inorganic particles themselves operate as the pore walls. This 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*.

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

100. 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 μm , D50: 0.66 μm , D90: 1.53 μm) was used as a filler." Ex. 1003 ¶ 77. I disagree.

a. The Plain Meaning of the Claims Require the Dv10, Dv50, and Dv90 Values to Be Satisfied By the Particle Sizes of the Particles When They Are In the Porous Layer

101. It would be axiomatic to a POSITA reading specifications of particle sizes to take those sizes as representative of the distribution of particles that truly exist in the completed porous film; otherwise those sizes would have no scientific connection to film structure and performance. It is my opinion that Petitioner's argument about Murakami's particle sizes is flawed because the reported particle size distributions of Murakami are measurements of particle size only *before* those particles are subject to and modified by high-pressure dispersion techniques and later become part of the porous layer. In contrast, the claimed particle size distributions are the particle sizes of the inorganic particles *in* the porous film, consistent with a POSITA's expectations.

102. The claim language of the '148 Patent itself is clear with respect to the fact that the particle size distributions are the particle sizes of the inorganic particles *in* the porous film because the claims provide particle sizes in terms of "pores at least comprise[s] a part of the inorganic particles." Specifically, the claims state: "the porous film comprises pores formed by the binder, the pores at least comprise[s] a

part of the inorganic particles, 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 .” This 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*.

103. Thus, to meet the claim language, Murakami would have to provide particle sizes that accurately reflect the particle sizes of the inorganic particles when those particles are operationally part of the porous film—not before the film is created. Murakami thus fails, as I will explain.

b. Murakami Does Not Meet This Requirement

104. 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. By analogy, if I buy two large rectangles of chocolate to make chocolate chunk cookies, the sizes of the chocolate chunks actually formed in the cookies will vary based on the steps actually

used during the manufacturing process, i.e. they will not be the same as the initial rectangles. Similarly, a POSITA would have understood that the particles sizes reported by Murakami were the initial sizes of those particles prior to adding the particles to the porous layer. For example, the examples are clear that they list the starting materials first, including α -alumina (D10: 0.22 μm , D50: 0.44 μm , D90: 1.03 μm), and then go into the steps of dispersion and mixing. A POSITA would have read the examples of Murakami and seen that “ α -alumina (D10: 0.22 μm , D50: 0.44 μm , D90: 1.03 μm) was used” (Ex. 1005 ¶ [0140].) and would have understood that those numbers represented initial particle distributions of alumina that could be purchased and used (a POSITA would know that alumina particles were widely commercially available for purchase in several different size distributions). That does not, however, mean that the particle size distribution of those particles remained the same after completing all of the steps of Murakami’s manufacturing process. In fact, they definitely would not, as I explain below.

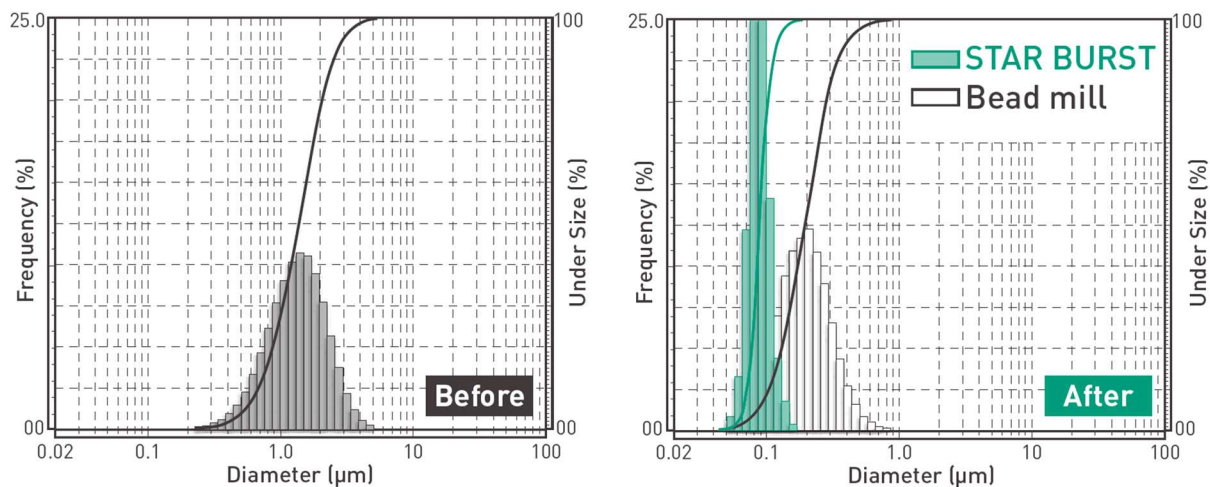
105. A POSITA would expect there to be a wide discrepancy between initial particle sizes used and corresponding final sizes in the porous layer because of the method Murakami uses to make the coating layer: high pressure dispersion. Ex. 1005 ¶ [0141]. Murakami discloses using the high-pressure dispersion technique not once, but *three* times, at a pressure of **100 MPa**. *Id.* (describing the “high-pressure dispersion condition” as “100 MPax3-pass”). That Murakami uses high-pressure

dispersion techniques is consistent with Murakami's stated goal of reducing inconsistency in voidage. This contrasts with the '148 Patent, which does not use high-pressure dispersion techniques.

106. A POSITA would have understood that using a high-pressure dispersion machine, sometimes called a jet mill and similar in principle to "sand blasting," to disperse the inorganic particles under high pressure dispersion techniques would necessarily (and intentionally) crack and pulverize the alumina particles used in Murakami, reducing them to significantly finer particle sizes, by inducing extremely high rates of shear and causing high-speed particle collisions and dispersion. Particles passing through this process would certainly not have the same final size distribution that they had when measured before applying the high pressure dispersion technique taught by Murakami. For example, the brochure for the same machine used in Murakami (the Sugino Machine Ltd. Star Burst) indicates that using the machine for ten passes at a pressure of 98 MPa (which is comparable to but even 2 MPa lower than the 100 MPa used in Murakami) on alumina (the same type of particle used in Murakami) at an average diameter of 20 μm *would reduce the average diameter of those particles to 0.2 μm , a hundred-fold decrease.* Ex. 2029 p. 5.

107. Indeed, it is not incidental to the use of a high-pressure dispersion machine that the particle size distribution is significantly altered; rather a POSITA

would know that reducing the particle size is a purpose of this highly energetic method of mixing. This process would inexorably (and intentionally) distort the initial size distribution of the particles that comprise the ultimate porous layer. For example, the Sugino Machine Ltd. Star Burst brochure illustrates (and advertises) the below change in particle size distribution after using the machine (again, which is the same machine used by Murakami):



Ex. 2029.

108. In the above plot a POSITA would readily observe how the “Before” particle size distribution (including corresponding D10, D50, and D90 values that can be read off the right-hand axes) is shifted to significantly smaller sizes and tremendously narrowed in the subsequent green “STAR BURST” results. The narrowing of the distribution means that the D90-D10 size difference would be notably decreased—as one example only, this machine reduced the average diameter

of certain alumina particles a hundred-fold (from 20 microns to 0.2 microns) when using pressure even lower than that advised by Murakami. Notwithstanding these data from Sugino Machine Ltd. for one particle source, the corresponding size changes for Murakami's own mixture, while in all likelihood severe, would be unknown to a POSITA without a difficult and expensive experimental effort to measure the particle size distribution after mixing and formation of the porous layer. Murakami did not undertake such efforts, does not display the particles or the particle size distribution after applying the high pressure dispersion technique, and as a result, the "before" D10, D50, and D90 values cannot be representative of the particle size distributions of the particles in the porous layer.

109. 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 ." The particle sizes of the initial alumina particles would undoubtedly be significantly reduced from the initial distribution of D10 = 0.22 μm , D50 = 0.44 μm , and D90 = 1.03 μm . Even a very small 4 percent reduction in the D90 particle size as a result of Murakami's high pressure dispersion technique and Sun Burst machine (which reduced other alumina particles with an average particle size of 20 μm to just 0.2 μm using even lower

pressure than Murakami used) would take the final product outside of the claimed Dv90 range of 1 μm to 10 μm .

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

110. Dr. Guido 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.

111. First, for the reasons set forth above in Paragraphs 104-108, it is my opinion that the particle sizes reported in Murakami are the sizes of the inorganic particles measured prior to being dispersed by high-pressure dispersion and thus do not represent the size of the inorganic particles when they are part of the porous film, which is required by the claims. For at least this reason, it is my opinion that Petitioner has not shown that Murakami discloses the claimed ratio range.

112. Second, Murakami does not even disclose the *ratio* of Dv90 to Dv10. Instead, it discloses a *difference* between Dv90 and Dv10. Ex. 1005 ¶ [0018]. A POSITA would have understood that the ratio of Dv90 to Dv10 (that is, a division measurement) is different from the difference between Dv90 and Dv10 (that is, a subtraction measurement) because the ratio more accurately reflects the size distribution of the particles. For example, if Dv10 is 1 μm and Dv90 is 1.1 μm , the difference (Dv90 - Dv10) would be 0.1 μm but the ratio (Dv90 / Dv10) would be 1.1. If instead Dv10 is 0.1 μm and Dv90 is 0.2 μm , the difference (Dv90 - Dv10)

would still be 0.1 μm but the ratio ($Dv90 / Dv10$) would be 2. A POSITA would need to take the ratio of $Dv90/Dv10$ to understand the distinction in distribution between the two examples (a ratio of 2 versus a ratio of 1.1.). As I describe below, understanding the *ratio*—not the “difference”—between these values is critical to the solution of the ’148 Patent.

113. Dr. Guido relies entirely on the theory that *if* a POSITA were to divide $Dv90$ by $Dv10$, which Murakami does not teach, the POSITA would end up with a ratio of 1.25 to 1000 (or 4.68 for Example 1, 5.88 for Example 2), and that range overlaps with the claimed ratio of 2 to 100. This argument fails to provide a reason why the POSITA would have divided $Dv90$ by $Dv10$ and fails to consider the criticality of the claimed ratio range, which Murakami did not appreciate and was only discovered by the inventors of the ’148 Patent.

114. The ’148 Patent explains that “[i]f $Dv90/Dv10$ is greater than 100” then this “will lead to the particle size distribution of the inorganic particles being too wide, the uniformity of the formed pores [being] poor, and polarization reactions [] easily occur[ring] in the lithium-ion battery.” *Id.* at 4:54-60. Thus, it is imperative to the ’148 Patent that the ratio of $Dv90$ to $Dv10$ not exceed 100. Indeed, a ratio of $Dv90$ to $Dv10$ is a dimensionless ratio in which length units advantageously cancel out and that mathematically leads to a preferred shape for the particle size distribution. This is distinct from Murakami’s “difference” between $Dv90$ and $Dv10$,

which has length units, is not dimensionless, and hence is meaningless unless tied to other particle size information, which Murakami does not teach a POSITA to do.

115. For this additional reason, it is my opinion that Murakami does not disclose or render obvious that “the inorganic particles have particle sizes that the ratio of Dv90 to Dv10 is in a range of 2 to 100.”

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

116. 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.

117. 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.

118. I reserve the right to provide any additional arguments as to dependent claims 3 and 12 later in the proceedings, should review be instituted.

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

119. 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.

120. 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.

121. I reserve the right to provide any additional arguments as to dependent claims 4 and 13 later in the proceedings, should review be instituted.

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

122. Petitioner contends that Murakami and Beard render obvious Claims 1, 2, 5-11, and 14-19 of the '148 Patent. These claims are reproduced above with respect to Ground 1.

123. Dr. Gido argues that, if Murakami does not meet the structural requirements of the pores (i.e. formed by the binder and comprising at least a part of the inorganic particles), then a POSITA would look to Beard for its pore structure. Indeed, for the same reasons noted above with respect to Murakami in Ground 1, it is my opinion that to a POSITA Murakami does not disclose or render obvious the claimed particle size distributions (Dv10, Dv50, or Dv90) or the claimed ratio of Dv90 to Dv10. For these reasons alone, this combination fails. Petitioner does not rely on Beard to address any of the particle size distribution limitations that are missing from Murakami in the independent claims 1 and 10 I have addressed above. Not only do I disagree that a POSITA would combine Murakami and Beard, but even if they were to combine these references, the combination of Murakami and Beard fails to disclose or render obvious all the claimed elements.

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

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

125. Dr. Gido opines that Beard discloses pores that “at least comprise a part of the inorganic particles” for three primary reasons: (1) Beard’s inorganic particles are part of the pore wall, and being a part of the pore wall is the same as being a part

of the pore itself; (2) even if the claims require the inorganic particles to be a part of the pore itself, Figure 1 allegedly shows some of the small inorganic particles poking out of the binder in the pore walls, and (3) Beard allegedly discloses larger particle sizes in the voids of the pores. Ex. 1003 ¶¶ 174-77. I disagree with Dr. Guido for at least the following reasons.

a. The Claim Limitation “Pores . . . At Least Comprise a Part of the Inorganic Particles” Requires At Least Some of the Inorganic Particles to Extend Into the Pores

126. I disagree with Dr. Guido’s assertion that because Beard’s inorganic particles are part of the pore wall that Beard (or the combination of Murakami and Beard) meets the claim language. Ex. 1003 ¶¶ 174-75. As explained above in Paragraph 97, the claims require that the “*pores . . . at least **comprise***” part of the inorganic particles.” The claim has two requirements that must be met at the same time. First, the pore must still be “formed by the binder” and second, the pore must “at least comprise a part of the inorganic particle.” The natural reading of these two requirements in conjunction is that the binder primarily defines the pore walls and shape, defining the geometry of the empty spaces or gaps, and the inorganic particles extend partially into those empty spaces (the pores). That is, a POSITA would have understood the claim language to require that at least some part of the inorganic particles be part of the pores themselves (i.e. the empty space) and not merely the

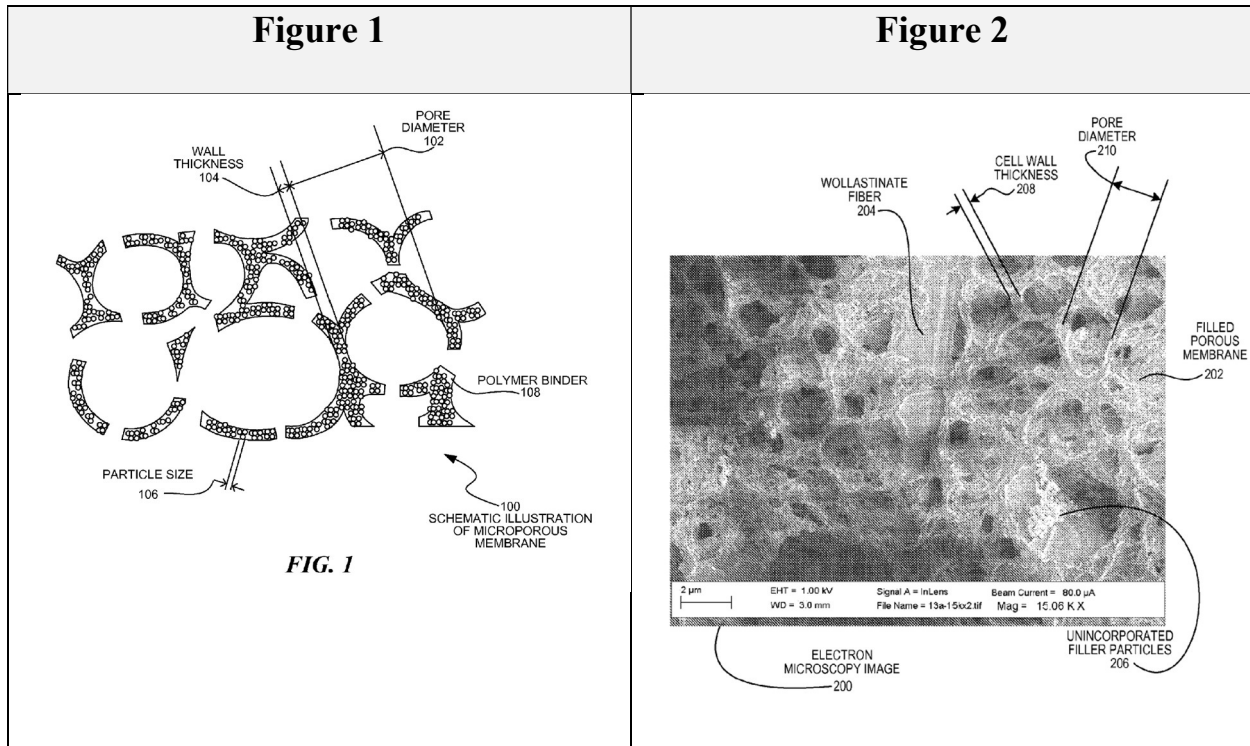
walls that surround the pores. This is due to the fact that a POSITA would have understood that the recited “pore” refers to an empty space divided from another empty space by an identifiable wall (i.e. “pore wall”).

b. The Particles In Beard’s Preferred Embodiment Are, At Best, Part of the Walls that Define the Pores, Not Part of the Pores Themselves

127. Second, Dr. Gido argues that some of the small particles in Beard (might) extend into the pore itself. Ex. 1003 ¶ 176. Dr. Gido’s analysis is flawed because he relies entirely on Figure 1 of Beard to draw his conclusions. Figure 1 appears to be a handwritten cartoon or conceptual drawing of what Beard’s inventors hoped to see in Beard’s pore structure, using literally identical circles to illustrate (from a conceptual level only) that Beard’s particles are fully dispersed within the binder resin. A POSITA would understand not to make conclusions about exact placement of particle locations relative to pore walls from such a conceptual drawing unless an accompanying exposition from Beard were to identify a critical feature such as this, which Beard does not do. A POSITA would thus be unable to tell with any level of certainty that Beard’s pores comprise at least a part of the inorganic particles.

128. Relying on the Figure 1 illustration to draw any kind of conclusion about pore structure is unscientific. Instead, a POSITA would at least have relied on Beard’s SEM images, not Figure 1’s conceptual illustration illustrating all of the

pores dispersed within the binder, to see if it is possible to determine information about Beard's pore structure, if any. The SEM images provided in Beard do not support Petitioner's interpretation of Figure 1. Rather, Figure 2 (SEM image below) shows a highly irregular surface structure with a great deal of variation from one region to the next, which violates the teaching of Murakami that variations in void fraction should be minimized. Hence, a POSITA would know not to rely on Beard to cure any deficiency in Murakami. Secondly, Figure 2 shows no intentional and regular incorporation of filler particles into the pores such that the pores comprise a part of the inorganic particles. The region of the SEM image labeled "UNINCORPORATED FILLER PARTICLES 206" appears to be a defect in which filler particles were not adequately mixed and dispersed (consistent with the label "unincorporated") and instead form an aggregate that is combined with binder and still forms a pore wall, albeit irregular in comparison to other smoother pore walls. The region of the SEM image labeled "WOLLASTINATE FIBER 204" appears to show extremely large fibers that, as described in paragraph [0038] ("The Wollastonite fibers have a diameter that is substantially larger than the pore diameter 210.") have such a large diameter that they completely occupy the volume such that there is no pore remaining in the vicinity of the fibers in this embodiment. Again, there is no pore shown in this SEM image that could conceivably comprise a part of the inorganic particles.



Ex. 1005 FIGS. 1 and 2

129. Moreover, Dr. Gido’s unfounded extrapolation from Figure 1, that some inorganic particles extend *into* the pores of Beard rather than staying within the walls, runs counter to Beard’s explicit disclosure. 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]. 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. 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]. Thus, a POSITA would understand that Beard teaches trapping the inorganic particles within the pore walls, rather than having them extend into the pores themselves.

130. If anything, Beard teaches away from pores that “at least comprise part of the inorganic particles.” Beard explicitly 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 Beard to **not** have the pores comprise any filler (e.g. inorganic particles or parts thereof).

c. The Particles In Beard’s Alternative Embodiment Define the Pore Structure, Leaving Beard’s Alternative Disclosure Lacking “Pores Formed by the Binder”

131. Third, apart from Figure 1, Dr. Gido relies on an *alternative* embodiment in Beard, in which “larger fibrous particles, greater than 1 micron 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].

132. Dr. Gido has provided no reason why a POSITA would have been motivated to choose this “second optional embodiment” over the primary embodiment illustrated in Figure 1 or why the POSITA would have combined this additional embodiment with Murakami, which teaches using far less binder (and far more filler particles) than Beard’s disclosure uses. Indeed, in his motivation to combine section with Murakami, Dr. Gido argues that one of the reasons a POSITA would have been motivated to combine Murakami and Beard is that Beard teaches that “[g]ood results may be achieved when the solid particles are contained exclusively or largely within the pore walls” *Id.* ¶ [0086]. But this benefit describes Beard’s preferred embodiment of Figure 1. So not only does Dr. Gido rely exclusively on the preferred Beard embodiment in his combination for this ground, but this disclosure in Beard dictates that a POSITA would have chosen to use the Figure 1 embodiment, which disclosed particles being contained within the pore walls, instead of the alternative embodiment with larger particles outside of the pore walls.

133. Even if a POSITA were to pursue this alternative embodiment, there is no evidence to suggest that the pores in this embodiment would be “formed by the binder.” In fact, Beard says the opposite. Beard states that the pores are formed by the larger filler particles. *Id.* (“***larger fibrous particles***, greater than 1 micron may extend through, across or between the pores ***creating a porous fibrous network***. . . .”)

(emphasis added). Thus, Beard clearly states that in this alternative embodiment, the “larger fibrous particles . . . create a porous network” (i.e. the larger fibrous particles create the pores, not the binder).

134. In other words, regardless of which embodiment a POSITA were to consider, Beard does not teach or suggest having pores that are *both* (1) formed by the binder and (2) comprise a part of the inorganic particles, as the claims require.

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

135. 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.

136. ***First***, Beard and Murakami have incompatible particle sizes and particle size distributions. Beard teaches using very 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*.”). Moreover, Beard explicitly teaches the importance of

those small inorganic particle sizes in achieving its pore structure. *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”).

137. In contrast, Dr. Gido points to much larger initial particle sizes in Murakami. *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.”). While these particles would necessarily be pulverized to smaller sizes for the reasons I described above, the extent to which they would be pulverized is not clear from Murakami’s disclosure, and if they were reduced to be comparable to Beard’s particle sizes, then the very small particle sizes in the modified Murakami and Beard would fall outside of the claimed particle size distribution required by the ’148 Patent.

138. A POSITA would have understood that the large particle sizes of Murakami and the extremely small particle sizes of Beard are mutually exclusive, such that the two references cannot be combined. Instead, a POSITA would have had to make a choice. That is, a POSITA would have two choices: (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. However, both particle sizes fail to disclose the invention.

139. First, if using the small particle sizes of Beard, a POSITA would expect the particles to fit fully within the pore walls like Beard discloses. *See* Paragraphs 127-130. Using the small particle sizes of Beard would mean the combination does not disclose either the claimed limitations of the pores comprising part of the inorganic particles or the claimed distribution ranges.

140. On the other hand, if using the larger particle sizes from Murakami, the particles would no longer be small enough to fit within the walls (i.e. be fully subsumed by the binder). For example, as explained above, Dr. Guido argues that Murakami discloses the following particle sizes: (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. If Dr. Guido is correct about Murakami's disclosure,⁵ 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. This would result in the pore structure not being formed by the binder but rather formed by gaps between large inorganic particles, like explained above with respect to Murakami. This would

⁵ As explained in detail above, because Murakami uses high pressure dispersion, these size distributions in Murakami are in fact not representative of the size distributions in the porous layer and thus, the size distribution ranges are not disclosed in Murakami.

also mean, as explained above with respect to Murakami, that the inorganic particles would be the pore *walls* and would not extend into the pores themselves, as is required to meet the limitation that the pores comprise at least a part of the inorganic particles.

141. **Second**, a POSITA would not have been motivated to combine Beard and Murakami because they use vastly different amounts of binder, which influences whether the pores can be “formed by the binder” or not. As explained above in Paragraph 88, Murakami teaches most preferably using only between 1 to 10% by mass of binder compared to mass of inorganic particles. Ex. 1005 ¶ [0070]. Contrast this amount with Beard, which discloses using at least 50% and as high as 200% by volume of binder compared to volume of 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.”). Dr. Guido does not attempt to wrestle with the inconsistency between the two reference’s disparate teachings about the preferred ratio of particles to binder, and does not explain how that would be resolved.

142. A POSITA would have understood that the large amount of binder in Beard is incompatible with the small amount of binder in Murakami, and thus the two references cannot (and would not) be combined for this additional reason. Specifically, Murakami teaches that a large amount of binder has deleterious effects and one should not use an amount that would fully disperse the filler within the

binder itself (Ex. 1005 ¶ 70), whereas in Beard such encapsulation and dispersion of filler particles is both intrinsic and desired. Hence, there are fundamental and irreconcilable differences in the teachings of Murakami and Beard with respect to the relative amount of binder in the porous layer and its purpose in relation to pore structure. A POSITA would have to choose one approach and would not be motivated to combine.

143. ***Third***, Beard and Murakami have incompatible mixing and dispersing procedures. As explained above, 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.

144. Moreover, Murakami teaches ***not*** encapsulating inorganic particles in a binder. Ex. 1005 ¶ [0070] (“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.”). Beard teaches the exact opposite. Ex. 1010 ¶ [0086] (“Good results may be achieved when the solid particles are contained exclusively or largely within the pore walls and when an open, continuous pore structure is provided throughout the film.”).

145. As explained above, Murakami’s procedure to remove solvent and form pores involves simply driving off solvent with heat. In contrast, Beard is unclear

about its procedure for removing solvent and forming pores. In Paragraph 59, all Beard says is to “remove the solvent” to begin the forming process and says nothing about how that solvent is removed. Paragraph 66 refers vaguely to “cooling and/or drying,” but does not describe the specifics of the “cooling and/or drying” process.

146. Dr. Gido does not identify which process, Murakami or Beard, a POSITA would have been motivated to use. Regardless of which reference is used, Murakami or Beard, neither describes the NIPS pore formation process disclosed in the '148 Patent. As explained above, in the '148 Patent, the key to pore formation is the coagulating step. *See* Paragraphs 56-58. This step explains how the binder interacts with itself and other elements to form the pores. Neither Murakami nor Beard disclose this coagulation process. Thus, even if a POSITA were to combine Beard with Murakami and did know which of the two processes to use, they would still not arrive at the claimed invention.

147. ***Fourth***, As pointed out in Paragraph 128 above, Beard’s SEM image in Fig. 2 shows a porous structure that is highly irregular. This explicitly violates the stated intention of Murakami to minimize variability in the porous structure. *See e.g.*, Ex. 1005 ¶ [0088]. A POSITA would be taught by Murakami to avoid an approach such as Beard’s that would lead to variability.

148. ***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. Guido suggests that a POSITA could use the particle sizes of Murakami but arrive at the porous structure of Beard. This is not the case.

149. Dr. Guido relies on Beard's disclosure of "good results" and the fact that Beard and Murakami both use solvent processes to argue there is a reasonable expectation of success. Ex. 1003 ¶¶ 179-80. But as Beard explains, its "good results" are achieved *because* Beard uses very small inorganic particles (0.005 μm , which falls outside the claimed particle size distribution in the '148 Patent) and keeps them trapped in a polymer that it has "good results." Ex. 1010 ¶ [0086]. Thus, using the large particle sizes of Murakami (up to 5.0 μm) would mean that the pores would no longer be "formed by the binder," but rather formed by inorganic particles like in Murakami, and thus the combination would not meet the claims. Alternatively, if a POSITA were to use the small particle sizes of Beard (less than 0.005 μm), then there is not even an argument that the particle size distribution limitations are met because those sizes fall far below the claimed size distributions.

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

150. It is my understanding that in Ground 5, Petitioner asserts and Dr. Guido opines that Murakami, Beard, and Honda render obvious Claims 3 and 12. Pet. at

48-56; Ex. 1003 ¶¶ 162-81. These claims are reproduced above with respect to Ground 2.

151. These claims are not obvious for the same reasons noted above with respect to Independent Claims 1 and 10, and as I addressed with respect to Ground 2.

152. I reserve the right to provide any additional arguments as to dependent claims 3 and 12 later in the proceedings, should review be instituted.

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

153. 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.

154. These claims are not obvious for the same reasons noted above with respect to Independent Claims 1 and 10, and as I addressed with respect to Ground 3.

155. I reserve the right to provide any additional arguments as to dependent claims 4 and 13 later in the proceedings, should review be instituted.

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

156. Petitioner contends that Beard and Akiike render obvious Claims 1-3, 5-12, and 14-19 of the '148 Patent. These claims are reproduced above with respect to Grounds 1 and 2.

157. 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"

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

159. 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.

160. I disagree with Dr. Guido’s analysis and conclusions.

161. **First**, I disagree with Dr. Guido that Beard is “lacking these implementation details.” *Id.* ¶ 200. A POSITA would have understood from Beard that it does not teach specific Dv10, Dv50, and Dv90 values but does teach other distribution requirements, namely an approximate range plus either a maximum particle size or an average or median particle size. Ex. 1010 ¶ [0022] (“The particle size 106 may vary from 0.005 to 0.1 microns, but may vary from 0.001 to 0.2 microns in some embodiments. In some embodiments, the particle size may be measured as a maximum size. . . . Some embodiments may measure particle size by an average or median particle size.”). The maximum particle size means that 100% of particles would be below that size. The average or median of the distribution

means that 50% of particles would be below a given diameter. Note that the above ranges taught by Beard are extremely small by the standards of battery materials, namely 5-100 nanometers or 1-200 nanometers (for comparison, the wavelength of visible light is 400-750 nanometers). At the very least, a POSITA would have understood that Beard is attaching no special significance to particle size distribution at Dv10, Dv50, and Dv90, so long as the particles are sufficiently small. Thus, there would be no reason for a POSITA to search for more detailed particle size distribution examples. Dr. Gido provides no reason why a POSITA would have been motivated to *not* use the particle size limits for the inorganic particles disclosed in Beard. Nor does Dr. Gido explain why a POSITA would think to place importance on particle size distribution at Dv10, Dv50, and Dv90 given that Beard does not.

162. **Second**, a POSITA would not have been motivated to use Akiike's particle size distributions because Beard teaches the importance of very small particle sizes, and Akiike discloses much larger particle sizes than would work with Beard. As explained above with respect to Ground 4, Beard teaches using very 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.*”). Moreover, Beard explicitly teaches the importance of those small inorganic particle sizes in achieving its pore structure. *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”).

163. In contrast, Akiike teaches using much larger particle sizes in its porous membrane. Ex. 1011 ¶¶ [0011]-[0013] (disclosing D10 values of 0.2 μm to 0.4 μm , D50 values of 0.5 μm to 0.9 μm , and D90 values of 1.0 μm to 3.0 μm). As I discussed with respect to the proposed combination of Murakami and Beard, this is incompatible with Beard’s extremely small particles sizes.

164. A POSITA would have understood that the large particle sizes of Akiike are incompatible with the extremely small particle sizes of Beard, such that the two references cannot be effectively combined. Again, a POSITA would have to choose either Beard’s particle sizes or Akiike’s particle sizes. As described above in Paragraph 149, if a POSITA chose Beard’s very small particle sizes, then there can be no argument alleging that the size distribution limitations are met. And if a POSITA chose to use Akiike’s larger particle sizes, then the particles would no longer fit within the pore walls as described in Beard. As explained above, the pore wall (i.e. binder) thickness in Beard is 0.02 μm or less. But Dr. Gido relies on particle size distributions in Akiike that far exceed this thickness. Ex. 1003 ¶¶ 196-98 (citing,

for example, disclosures where D10 is 0.2 μm to 0.4 μm , D50 is 0.5 μm to 0.9 μm , and D90 is 1.2 μm to 2.0 μm). Using these much larger particle sizes would mean that the pores would be formed by the inorganic particles and gaps between them, rather than by the binder (as required in the claims).

165. **Third**, a POSITA would not have been motivated to combine Beard and Akiike because they use vastly different amounts of binder, which influences whether the pores can be “formed by the binder” or not.

166. 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 as high as 10% by mass of binder compared to non-conductive particles.

167. As just described, Beard discloses binder-to-particle ratio in terms of volume and Akiike discloses binder-to-particle ratio in terms of mass. For a POSITA to quantitatively compare the two would require knowledge of respective binder and inorganic/non-conductive particle densities, which are non-trivial to obtain. Nevertheless, with only approximate densities in hand, a POSITA would have

intuitively understood that the large amount of binder in Beard is incompatible with the small amount of binder in Akiike, and thus the two references cannot be combined for this additional reason. Like with the Murakami and Beard proposed combination, a POSITA would have two options: (1) choose between Beard's amount of binder and Akiike's amount of binder, or (2) try to come up with some middle ground, not using the inventions of Beard *or* Akiike. Neither option would lead a POSITA to arrive at the claimed invention.

168. Beard teaches that the large amount of binder (up to 200% by volume ratio) is critical to the pore structure (i.e. having pore walls made of binder). A POSITA would have understood that using the very small amount of binder disclosed in Akiike means that there would not be enough binder to form the pore walls like in Beard. Thus, if a POSITA chose the amount of binder in Akiike (like Dr. Guido suggests), the pores would not be formed by the binder.

169. ***Fourth***, Beard and Akiike have incompatible bonding and dispersing properties.

170. Beard teaches engulfing 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. . .”).

171. In contrast, 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 is the type of bonding that I previously described as the binder acting like “little dots of glue” to hold the inorganic particles together. Akiike teaches that this type of bonding 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.” *Id.* In other words, Akiike teaches that the pores are not formed by the binder but rather are formed by “space[s] between the non-conductive particles.” *Id.* Dr. Guido does not explain which bonding and dispersion technique to use, and a POSITA would not be able to use both.

172. **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.

173. Dr. Guido provides only a conclusory opinion that a POSITA would have had a reasonable expectation of success in using Akiike’s particle size distributions in Beard’s porous membrane because (1) both Beard and Akiike use a

polymer binder and (2) both use titanium dioxide as their inorganic particles. *Id.*

¶ 205. I disagree that this results in a reasonable expectation of success.

174. As Beard explains, it is *because* Beard uses very small inorganic particles and keeps them trapped in a polymer that it has “good results.” Ex. 1010 ¶ [0086]. Using the large particle sizes of Akiike would mean that the pores would no longer be formed by the binder, but rather would be formed by the nonconductive particles (Ex. 1011 ¶ [0094]), and thus the combination would not meet the claims. Alternatively, if a POSITA were to use the small particle sizes of Beard, then there is not even an argument alleging that the particle size distribution limitations are met.

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

175. 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.

176. These claims are not obvious for the same reasons noted above with respect to Independent Claims 1 and 10.

177. I reserve the right to provide any additional arguments as to dependent claims 4 and 13 later in the proceedings, should review be instituted.

VIII. CONCLUSION

178. 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 June 6, 2025 in Provo, Utah.

A handwritten signature in black ink, appearing to read "Dean R. Wheeler". The signature is fluid and cursive, with the first name "Dean" and last name "Wheeler" clearly distinguishable.

Dean R. Wheeler