

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

ZHUHAI COSMX BATTERY CO., LTD.

PETITIONER

v.

MAXELL, LTD.

PATENT OWNER

***INTER PARTES* REVIEW NO. IPR2023-00226**
PATENT 9,166,251

PETITION FOR *INTER PARTES* REVIEW UNDER 35 U.S.C. § 312

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PETITIONER'S EXHIBIT LIST

Exhibit	Shorthand	Description
1001	'251 Patent	U.S. Patent No. 9,166,251 (the '251 Patent)
1002	File History	Prosecution History of the '251 Patent
1003	Juzkow Declaration	Declaration of Marc Juzkow
1004	Juzkow CV	<i>Curriculum Vitae</i> of Marc Juzkow
1005	Yoshida	European Patent Application Publication EP 1115166
1006	Katayama	International Patent Application Publication WO 2007/066768
1007	Miyatake	Japanese Patent Application Publication No. 2007-335294
1008	JP 575	Japanese Patent Application No. 2007-259575
1009	Roth	Abuse Response of 18650 Li-Ion Cells with Different Cathodes Using EC:EMC/LiPF ₆ and EC:PC:DMC/LiPF ₆ Electrolytes, <i>ECS Transactions</i> , 11 (19) 19-41 (2008) November 19, 2007
1010	Dahn	Thermal stability of Li _x CoO ₂ , Li _x NiO ₂ and b-MnO ₂ and consequences for the safety of Li-ion cells, <i>Solid State Ionics</i> 69 (1994) 265-270
1011	Arora	Battery Separators, Pankaj Arora and John Zhang, <i>Chem. Rev.</i> 2004, 1004, 4419-4462
1012	Harris	F.W. Harris, <i>J. Chem. Ed.</i> , 58, (11), 837, 1981
1013	Celgard	U.S. Patent No. 6,432,586
1014	Linden	"Handbook of Batteries", David Linden, Thomas Reddy, McGraw-Hill, 3 rd Ed., 2001

1015	LG Patent	International Patent Application Publication WO 2006/068428
1016	Maleki	<i>Thermal Stability Studies of Li-Ion Cells and Components</i> , Hossein Maleki, Guoping Deng,* Anaba Anani, and Jason Howard, Journal of The Electrochemical Society, 146 (9) 3224-3229 (1999)
1017	Xiaoping	U.S. Patent Application Pub. No. US 2004/0209156
1018	Samii	U.S. Patent No. 6,949,315
1019	JP 527	Japanese Patent Application No. 2008-039527
1020	ATL Petition	<i>Amperex Tech. Ltd. v. Maxell, Ltd.</i> , IPR2021-01442 (PTAB Sept. 23, 2021) (Paper 2)
1021		Draft Stipulation

I. INTRODUCTION

The '251 Patent describes a separator for use in a nonaqueous electrolyte battery. EX1001, Abstract. The '251 Patent asserts that prior art systems are susceptible to short circuit due to the thermal shrinkage of the separator. *Id.*, 1:67-2:1. The '251 Patent purports to solve this problem with “a battery separator that can constitute a nonaqueous electrolyte battery having excellent safety in a high-temperature environment, and a nonaqueous electrolyte battery using the battery separator.” *Id.*, 2:15-19. The separator “reliably prevent[s] a short circuit due to contact between the positive electrode and the negative electrode at high temperatures.” *Id.*, 2:54-56.

But Yoshida previously described such a nonaqueous electrolyte battery separator and battery including the separator. EX1005, [0001], [0006]; EX1003, ¶46. Katayama also disclosed a nonaqueous electrolyte battery including a separator formed of a heat-resistant layer and a shutdown layer. EX1006, [0002], [0015] (overall structure), [0022] (shutdown layer), [0023] (heat-resistant layer), [0073] (separator can be “integrated with the electrodes”); EX1003, ¶55. Katayama further described specific details about the materials and dimensions of the separator layers. *See, e.g.*, EX1006, [0082] (thickness); EX1003, ¶56. Accordingly, Yoshida in combination with Katayama renders obvious the challenged claims.

II. MANDATORY NOTICES

A. Real Party in Interest (37 C.F.R. §42.8(b)(1))

The real parties-in-interest is Zhuhai CosMX Battery Co., Ltd.

B. Related Matters (§42.8(b)(2))

The following proceedings may affect, or be affected by, a decision in this proceeding.

(1) *Amperex Tech. Ltd. v. Maxell, Ltd.*, No. 2:21-cv-08461-KM-MF (D.N.J. Apr. 6, 2021), in which the '251 Patent is asserted, is terminated and transferred to the Western District of Texas.

(2) *Maxell, Ltd. v. Amperex Tech. Ltd.*, No. 6:21-cv-00347-ADA (W.D. Tex. Apr. 8, 2021), in which the '251 Patent is asserted.

(3) *Maxell, Ltd. v. Zhuhai CosMX Battery Co., Ltd.*, No. 6:21-cv-00845-ADA (W.D. Tex. Aug. 13, 2021), in which the '251 Patent is asserted.

(4) *Amperex Tech. Ltd. v. Maxell, Ltd.*, No. 6:21-cv-01007 (W.D. Tex. Sept. 29, 2021), in which the '251 Patent is asserted, is terminated and consolidated with Civil Case No. 6:21-cv-00347-ADA.

(5) *Amperex Tech. Ltd. v. Maxell, Ltd.*, IPR2021-01442 (PTAB Sept. 23, 2021), in which the '251 Patent is challenged.

C. Lead and Back-Up Counsel (§42.8(b)(3))

Lead Counsel	Back-Up Counsel
Eagle H. Robinson (Reg. No. 61,361)	Charles B. Walker, Jr. (Reg. No. 43,231)

D. Service Information (§42.8(b)(4))

Lead Counsel	Back-Up Counsel
Eagle H. Robinson Norton Rose Fulbright US LLP 98 San Jacinto Boulevard, Suite 1100 Austin, TX 78701 512.536.3083 (telephone) 512.536.4598 (facsimile) eagle.robinson@nortonrosefulbright.com	Charles B. Walker, Jr. Norton Rose Fulbright US LLP Fulbright Tower 1301 McKinney, Suite 5100 Houston, TX 77010-3095 713.651.5151 (telephone) 713.651.5246 (facsimile) charles.walker@nortonrosefulbright.com

Petitioner consents to electronic service.

III. GROUNDS FOR STANDING

Pursuant to §42.104(a), Petitioner certifies that the '251 Patent is available for IPR, and that Petitioner is not barred or estopped from requesting an IPR on the grounds identified in this Petition.

IV. STATEMENT OF PRECISE RELIEF REQUESTED FOR EACH CLAIM CHALLENGED

A. Claims for Which Review Is Requested (§42.104(b)(1))

Petitioner requests review and cancellation of Claims 1-37.

B. Statutory Grounds of Challenge (§42.104(b)(2))¹

Claims 1-37 are invalid under §103(a) over these combinations of art:

¹ All Grounds are supported by a POSITA's general knowledge. *Koninklijke Philips N.V. v. Google LLC*, 948 F.3d 1330, 1337-38 (Fed. Cir. 2020).

Ground	Claims	Prior Art Combination
1	1-37	Yoshida (EX1005), Katayama (EX1006)

Filed June 22, 1999 and published July 11, 2001, Yoshida is prior art under §§102(a), (b).

Filed December 8, 2005 and published June 14, 2007, Katayama is prior art under §§102(a), (b).

V. THE GROUNDS IN THIS PETITION ARE NOT CUMULATIVE

A. The Prosecution History Does Not Weigh Against Institution

The proposed grounds are not cumulative over the art or arguments analyzed during prosecution. Yoshida² and Katayama were before the Examiner (EX1002, 694/946), but were not involved in any rejections or specific analysis. *Id.*

To the extent Patent Owner may argue the Examiner considered Yoshida and Katayama in accepting the Applicant's arguments that the prior art failed to disclose the specific layer thicknesses, thickness ratio, and vol % of heat-resistant fine particles in the heat-resistant layer (*id.*, 873/946), the Examiner erred.

Katayama discloses thickness ranges for each separator layer, including 1-15 µm (preferably 3-10 µm) for the shutdown layer, and is 2-30 µm (preferably 4-20 µm) for the heat-resistant layer. EX1006, [0082]; *see also* Section IX.A.5,

² PCT Publication (WO 00/79618) cited on face of '251 Patent. EX1001.

Limitation 1[f]. Additionally, Katayama discloses “the content of the filler in the second separator layer is preferably at least 50 vol. % ... further preferably at least 80 vol. % .” EX1006, [0059]; *see also* Section IX.A.5; Limitation 1[g]. As set forth below, the Examiner erred by allowing the claims over the prior art on which this Petition relies, and the lack of analysis during prosecution weighs against discretionary denial. *Advanced Bionics, LLC v. MED-EL Elektromedizinische Geräte GMBH*, No. IPR2019-01469, Paper 6 at 10-11 (P.T.A.B. Feb. 13, 2020).

B. The Prior IPR Petition Does Not Weigh Against Institution

The *General Plastic* factors weigh against discretionary denial. *Gen. Plastic Indus. Co., LTD. v. Canon Kabushiki Kaisha*, IPR2016-01357, Paper 19 at 15-21 (P.T.A.B. Sept. 6, 2017) (precedential).

Factor 1. The previous IPR petition challenging the '251 Patent was filed by a different petitioner. *See* EX1020. This weighs against discretionary denial.

Factors 2-4. The previous petitioner included Yoshida and Katayama in grounds presented in the earlier-filed IPR. *See* EX1020, 17-18/88. However, the grounds here are different from those in the prior petition.

The previous petition relied on a combination of Yoshida, Nagayama, Takezawa, and Amagi as the foundation of its obviousness theories, and only added Katayama as a fifth reference for certain dependent claims. *See* EX1020, 2, 60/88. Rather than merely adding references to address arguments made by PO there, this

petition presents unique grounds based on Yoshida and Katayama as the primary and second references. *See* § IX.A below.

Second, this petition relies on Yoshida's $\leq 0.5 \mu\text{m}$ particle size limit, in combination with Katayama's explicit disclosure of an exemplary particle size range and distribution that falls within the claimed ranges. *See* §§IX.A.3, IX.A.4, IX.A.5; (Limitation 1[h]). In contrast, the previous petition relied on a different primary reference, Kasamatsu and did not identify any particular particle size or explicit limits. EX1020, 34-35/88.

Third, this petition provides additional evidence of the characteristics of the materials underlying a POSITA's motivation to combine the teachings of Katayama with Yoshida with a POSITA's underlying knowledge of separators, positive active materials, and batteries to establish why the combination would have been obvious and expected to have a reasonable likelihood of success.

Thus, Petitioner is not using the prior IPR's POPR or institution decision "as a roadmap" for new grounds, and the Board has not previously considered the merits of the grounds proposed here.

Factor 5. Petitioner here is not related to the petitioner in the earlier-filed IPR; thus, this factor is neutral. *See Gen. Plastic*, IPR2016-01357 at 16-18; *Patent Quality Assurance, LLC v. VLSI Tech. LLC*, IPR2021-01229, Paper 10 at 8-11 (P.T.A.B. Jan. 26, 2022). Petitioner has no relationship with the earlier petitioner.

See Samsung Elecs. Co., Ltd. v. Scramoge Tech. Ltd., IPR2022-00385, Paper 14 at 13 (P.T.A.B. June 23, 2022) (“In this circumstance, we find that *General Plastic* factor 5 is neutral.”).

Factors 6-7. Factors 6 and 7 favor institution because the Board has not yet evaluated the validity of the ’251 Patent based on the grounds presented here, rendering this IPR “an effective and efficient alternative to district court litigation.” *Gen. Plastic*, IPR2016-01357 at 16-18.

C. The Board Should Not Discretionarily Deny Institution Under 35 U.S.C. §314(A)

Petitioner stipulates that, “if the Patent Trial and Appeal Board institutes IPR ..., then CosMX will not pursue in this case any of the grounds raised, or that reasonably could have been raised, in the one or more instituted IPRs...” EX1021. Because this stipulation is identical in breadth to the stipulation described on page 7 of *USPTO Memorandum, Interim Procedure for Discretionary Denials in AIA Post-Grant Proceedings with Parallel District Court Litigation* (June 21, 2022), “the PTAB will not discretionarily deny institution of an IPR or PGR in view of parallel district court litigation.” *Id.*

VI. LEVEL OF ORDINARY SKILL IN THE ART

A POSITA as of September 30, 2008³—the '251 Patent's earliest priority date to which the '251 Patent is entitled, (*see* §VIII.E)—would have had a bachelor's degree in chemistry, chemical engineering, materials science, or a related field, and at least three to four years of experience in design, development, and/or testing of batteries and battery materials, or the equivalent, with additional education substituting for experience and vice versa. EX1003, ¶¶19-21. The prior art and the '251 Patent also evidence this level of ordinary skill. *See Chore-Time Equip., Inc. v. Cumberland Corp.*, 713 F.2d 774, 779 (Fed. Cir. 1983); *Okajima v. Bourdeau*, 261 F.3d 1350, 1355 (Fed. Cir. 2001).

VII. FIELD OF TECHNOLOGY

The field of battery technology is well-developed with the below-described features and properties, among others, known to a POSITA. EX1003, ¶22-44.

A. General Battery Function

Nonaqueous electrolyte batteries, like lithium ion batteries, have long been popular power sources for cellphones and laptop computers. EX1001, 1:22-26; EX1003, ¶23. Conventional lithium ion batteries were typically limited to a charge

³ All statements in this Petition about the knowledge and skills of, and what would have been obvious to, a POSITA are offered from this perspective as of this date.

potential of 4.2 V. EX1017, [0003]. However, it was known to a POSITA that “the positive electrode materials and negative electrode materials used in the current secondary lithium ion battery have relatively higher theoretical capacity, and the problem merely lies in the lower actual utilization rate of said capacity.” *Id.* By the early 2000s, charge potentials of 4.35 V and more were known for lithium ion batteries. *See, e.g., id.*, [0019] (disclosing “charge cut-off voltages from 4.2 V to 4.3 V, 4.35 V, 4.40 V, 4.45 V, and 4.6 V”).

A battery consists of one or more cells, connected in series, parallel or a combination thereof. EX1003, ¶24. Each battery cell has (a) a negative electrode (“anode”) and a positive electrode (“cathode”)—each with active material(s), binder(s); (b) an electrolyte containing a lithium salt(s) dissolved in a liquid solution; and (c) a separator positioned between the anode and cathode. EX1013, 1:44-51, 2:1-3:8; EX1003, ¶24.

When a load is connected to the battery cell, lithium ions in the negative electrode are deintercalated (migrate) into the electrolyte as positive ions and electrons are released through the current collector. EX1015, 2:8-26; EX1003, ¶25. The lithium ions are transported via the electrolyte to the positive electrode and, simultaneously, electrons move from the negative electrode to the positive electrode through the external load, powering the device. EX017, 1:51-58; EX1003, ¶25.

The separator is positioned between the cathode and anode, electrically isolating the electrodes but allowing for ionic transport through the separator's pores which are filled with the electrolyte. EX1013, 2:60-63, 3:9-25; EX1003, ¶26. Contact between the electrodes will short the battery, risking a thermal runaway. EX1013, 1:27-35; EX1003, ¶26. Thermal runaway results when the interior of the cell reaches a temperature at which the internal components react, releasing energy in the form of heat, sparks, smoke and/or fire. EX1013, 1:27-35; EX1003, ¶26.

B. Existing Separators

In the 1990s, separators in lithium-ion cells typically included a single, microporous layer of polypropylene (PP). *See* EX1014, 1077. The most common was Celgard 2400 (25 um separator, 40% porosity). EX1014, Table 34.15; EX1011, 4443-44 (Table 4); EX1003, ¶27. Celgard 2400 was commonly used due to its (1) high porosity for low internal impedance and high rate capability; (2) tortuous paths in its pores to prevent lithium dendrite growth; (3) ease of filling with electrolyte; and (4) physical strength for handling during manufacturing and safety in mechanically abusive conditions (e.g. heavy impact). *See* EX1011, Table 4; EX1003, ¶27.

If the internal temperature of a cell exceeded ~165° C, the PP would melt, closing the separator's pores to halt ionic flow. EX1011, Table 4; EX1003, ¶28. If, however, the temperature continued to increase, the PP separator would eventually

shrink in the planar direction, shorting the battery and leading to thermal runaway. EX1013, 1:27-35; EX1003, ¶28. Ultimately, it was found that in excess of 165°C, PP separators would not prevent all thermal runaways. *See* EX1011, 4436-40, EX1003, ¶28.

Two main options were recognized: (1) shutting the cell down at a lower temperature and/or (2) preventing the separator shrinking at temperatures above the separator's melting point. EX1014, 1102-03.

First, it was discovered that some polyethylene (PE) films would melt at ~135°C, lowering the shutdown temperature, but would also exhibit shrinkage at a lower temperature than PP. EX1014, 1102-03; EX1003, ¶30. PE therefore could provide a lower shutdown temperature, but increased risk if the temperature continued to rise because PE shrinks at an even lower temperature than does PP. EX1011, 4424, EX1003, ¶30.

To address this issue, Celgard developed Celgard 2320, a three-layer polymer separator with a PE layer between two PP layers. EX1011, 4423-24, Table 4; EX1003; ¶31. PE provided early shutdown (~135° C), and PP provided higher melt integrity (less shrinkage) up to about 183°C. EX1011, 4434-35 (Table 6); EX1003, ¶31. In some cases, even the PP shrinking temperature was too low to prevent contact between electrodes. EX1003, ¶31.

Second, POSITAs added a heat resistant layer (e.g., with ceramic) to the separator to prevent substantial separator shrinkage at temperatures above those at which PP shrank. EX1011, 4423-24 (disclosing an example); EX1003; ¶32.

C. Separator Features

As more companies began developing lithium-ion cells, multiple separator styles were used. EX1003, ¶33. A POSITA would have understood that the separator influences various characteristics of cell performance, including cell capacity and volumetric energy density, high-rate performance, high-temperature storage, and safety. EX1011, Table 7; EX1003, ¶33.

Many features impact the performance and safety, including the active cathode materials, which had varying thermal stability (temperature at which they reacted to generate heat and oxygen). EX1009, Fig. 8, EX1011, 4429-35. The size of the pores and the percentage porosity were also factors as porosity affects the internal resistance. EX1009, Fig. 8, EX1011, 4429-35.

The thickness of the separator must also be considered as thicker separators have less volume available for active materials, and cells exhibit lower capacity and volumetric energy density. EX1011, Table 7; EX1003, ¶35. From a performance standpoint, cell designer prefers a thin separator but must consider the strength of the separator in handling during cell assembly. EX1011 Table 7; EX1003, ¶35.

A POSITA would have also understood the importance of ensuring sufficient separator strength and considered the size of particles when designing a cell. EX1003, ¶36. Strong 16 μm and 20 μm separators (e.g., Celgard 2320) are available. EX1011, 4424-46.

Finally, a POSITA would have understood that shutdown temperature of a shutdown layer was adjustable by selecting and/or adjusting the composition of the thermoplastic resin (e.g., vol %, ratio, and density). *See* §VII.C; EX1003, ¶37. A POSITA would have known that polymers (e.g., thermoplastic resins) are characterized by their molecular weight. *See* EX1012 at 840-841. A POSITA would have understood that selecting or combining thermoplastic resins with different molecular weights would have varied the melting temperature and resulting shutdown temperature. EX1003, ¶37.

D. Positive Active Materials

A POSITA designing a lithium-ion cell would have been familiar with the general properties of the positive active materials, and understood that the positive electrode material would have impacted the characteristics of a battery, including heat generation starting temperature. EX1003, ¶¶38-39. In other words, a POSITA would have known which materials may exhibit “high” heat generation temperatures or “low” heat generation temperatures. *Id.* While a POSITA could have run Thermal Gravimetric Analysis (TGA), Differential Scanning Calorimetry (DSC) or

Accelerated Rate Calorimetry (ARC) tests to determine the exact heat generation starting temperature, these values were available in the literature. *See* EX1009, EX1010, EX1016. A POSITA would have been familiar with the “high” heat generation temperatures of LiMn_2O_4 , LiMPO_4 (wherein M is Co, Ni, Mn, or Fe), and $\text{LiCo}_{0.33}\text{Ni}_{0.33}\text{Mn}_{0.33}\text{O}_2$. *See* EX1006, [0106]; EX1003, ¶39.

A POSITA would recognize that positive active materials would have influenced separator melting and shrinkage temperatures. *Id.*, ¶40. For example, positive active materials with lower thermal stability (i.e., that undergo exothermic reactions at lower temperatures) require separators that shutdown at lower temperatures. *Id.* Separator shutdown is needed for added safety, but must occur prior to the exothermic reactions. *Id.* Positive active materials with higher thermal stability require separators that do not shrink at lower temperatures, where contact between the electrodes would generate significant heat increasing the internal cell temperature to the onset temperature of the exothermic reaction. *Id.* Similarly, thermal stability and thermal runaway temperatures were known for different positive electrodes and for the shutdown temperatures of various separators. *See e.g.*, EX1009, 38 (disclosing shutdown temperatures for three examples); EX1010.

E. Separator Production

A POSITA would have known that there were two primary microporous film manufacturing processes for lithium-ion cells: the dry process, which uses a polymer

raw material, and the wet process, which uses a polymer and solvent and optionally fillers. EX1003, ¶41.

The dry process begins with the melting of a polyolefin resin and extruding the resin into a film bubble. *Id.*, ¶42. The film is annealed and stretched, resulting in an anisotropic structure with tortuous micropores. *Id.*

The wet process involves mixing a hydrocarbon liquid with a polyolefin resin, heating and melting the mixture, then extruding onto a sheet and extracting the liquid. *Id.*, ¶43. The properties and structure of these films can be modified by controlling the composition of the solutions in the gelation and solidification processes, and by the stretching step. *Id.* Ultrahigh molecular weight PE resin is preferred to provide mechanical strength with increased melt integrity. *Id.* However, the wet process may result in larger pore sizes and higher overall porosity. *Id.*

A dry drawn anisotropic separator has better mechanical strength in the machine direction (length) versus the transverse direction (width). EX1003, ¶44. Wet processes result in similar mechanical strength in all directions. *Id.* When exposed to elevated temperatures, wet-process separators typically shrink in both directions, whereas dry-process separators will shrink in the machine direction, not the transverse direction. *Id.*

VIII. '251 PATENT

Entitled “Battery Separator and Nonaqueous Electrolyte Battery,” the '251 Patent is directed to a battery and battery separator having “excellent safety in a high-temperature environment.” EX1001, 2:56-58; *see also id.*, 1:16-18, 2:14-19.

A. Overview

The '251 Patent describes a separator for use in a nonaqueous electrolyte battery. *Id.*, Abstract. “To suppress thermal shrinkage and provide a shutdown property, it is preferable that the separator of the nonaqueous electrolyte battery of the present invention has a multilayer structure ... includ[ing] a heat-resistant layer for suppressing the thermal shrinkage and isolating the positive electrode from the negative electrode at high temperatures and a shutdown layer.” *Id.*, 4:27-34.

The thickness of the shutdown layer “is preferably 5 μm to 30 μm .” *Id.*, 9:54-56. The thickness of the heat-resistant layer “is in the range of preferably 1 μm , more preferably 2 μm , even more preferably 4 μm to preferably 20 μm , more preferably 10 μm .” *Id.*, 9:56-60. Further, the sum of the thickness of the two layers is between 6 and 23 and the ratio of the thickness of the heat-resistant layer to the thickness of the shutdown layer is between 0.5 and 4. *Id.*, Claim 1.

“The heat-resistant layer ... is preferably a porous layer including heat-resistant fine particles and a binder” *Id.*, 5:3-5. “Specific examples of the inorganic fine particles include ... inorganic oxides such as an iron oxide, silica

(SiO₂), alumina (Al₂O₃), TiO₂, and BaTiO₃” *Id.*, 5:10-20. “The content of the heat-resistant fine particles in the heat-resistant layer is ... more preferably 50 vol % or more ... of components in the heat-resistant layer.” *Id.*, 8:12-15. The heat-resistant fine particles range in average size from 0.2 μm to 2 μm, with no more than 10 vol %, respectively, being less than 0.2 μm or over 2 μm. *Id.*, 5:62-6:3.

“[T]he shutdown temperature is preferably at least 20° C. lower than the exothermic peak temperature of the positive electrode (i.e., the temperature at an apex of the exothermic peak of the DSC curve that is obtained to determine the heat generation starting temperature, as described above), and more preferably 150° C. or lower.” *Id.*, 4:46-59.

B. Prior Art and Perceived Shortcomings

The '251 Patent describes that a “commonly used separator easily shrinks when the temperature in the battery becomes extremely high, and can cause a short circuit.” *Id.*, 1:33-35. Additionally, existing separators had thicknesses of 30 μm or less and short circuits occurred. *Id.*, 1:52-55. Existing technology focused on thermal shrinkage at 120°C and failed to ensure safety at higher temperatures. *Id.*, 1:55-64.

C. '251 Patent's Asserted Improvement to Prior Art

To overcome the purported shortcomings, the '251 Patent proposes a battery separator that purports to “reliably prevent a short circuit due to contact between the

positive electrode and the negative electrode at high temperatures.” *Id.*, 2:54-56.

“As a result ... , it is possible to provide a nonaqueous electrolyte battery having excellent safety in a high-temperature environment.” *Id.*, 2:56-58.

D. Prosecution History

The '251 Patent was filed on February 17, 2010. In a first Office Action, the Examiner rejected the claims as obvious over US 2008/0038631 (Nakura) and US 2007/0264577 (Katayama '577). EX1002, 685/946; EX1003, ¶108. In response, Applicant amended certain claims, including claim 1 to require at least 50 vol % of heat-resistant particles and claims 3 and 14 to require at least 80 vol % of heat-resistant particles. EX1002, 752-53/946, 755/946, 759-60/946; EX1003, ¶108.

After further Office Actions (EX1002, 797–820/946, 828–835/946; EX1003, ¶109-10), Applicant amended independent claim 1 to require that “the shutdown layer has a thickness A (μm) of 5 to 30, the heat-resistant layer has a thickness B (μm) of 1 to 10, a sum of A and B is 6 to 23, and a ratio A/B is 1/2 to 4” to overcome Nakura, (EX1002, 839/946, 849/946), and, subsequently argued that the cited combination would lead to a short-circuit, after which the Examiner allowed the case. EX1002, 879/946, 885–891/946; EX1003, ¶109-10.

E. Priority Date

The challenged claims are not entitled to the foreign priority applications' priority dates because their disclosures do not demonstrate PO was in possession of

the claimed invention. *See Studiengesellschaft Kohle m.b.H. v. Shell Oil Co.*, 112 F.3d 1561, 1564 (Fed. Cir. 1997); EX1003, ¶111. The '251 Patent discloses “a proportion of particles with a particle size of 0.2 μm or less in the heat-resistant fine particles is 10 vol % or less and a proportion of particles with a particle size of 2 μm or more in the heat-resistant fine particles is 10 vol % or less.” EX1003, ¶111. Neither priority document (EX1008 or EX1019) disclose this limitation and only provide average particle sizes, not the claimed size distribution. *Contrast* EX1001, 15:53-57 *with* EX1008, [0083] and EX1019, [0107]; EX1003, ¶111. The priority documents only provide a single reference to 0.001-15 μm (EX1008, [0033]) or 0.01-10 μm (EX1019, [0025]). Such statements cannot establish possession of the much narrower claimed range (<10 vol. % below 0.2, <10 vol. % above 2 μm). *In re Wako Pure Chem. Indus., Ltd.*, 4 F. App'x 853, 857 (Fed. Cir. 2001) (non-precedential) (holding applicant was not entitled to foreign priority application where the foreign priority document disclosed a broad range of compounds and the claims covered a narrower subset within that range); *Gen. Hosp. Corp. v. Sienna Biopharmaceuticals, Inc.*, 888 F.3d 1368, 1372 (Fed. Cir. 2018) (“The disclosure of a broad range of values does not by itself provide written description support for a particular value within that range.”); EX1003, ¶111. As such, the earliest possible priority date of the challenged claims of the '251 Patent is the filing date of the PCT application: September 30, 2008.

F. Claim Construction (37 C.F.R. § 42.104(b)(3))

Claim terms are given their “ordinary and customary meaning ... as understood by [a POSITA] and the prosecution history.” 37 C.F.R. § 42.100(b).

1. Particle Size

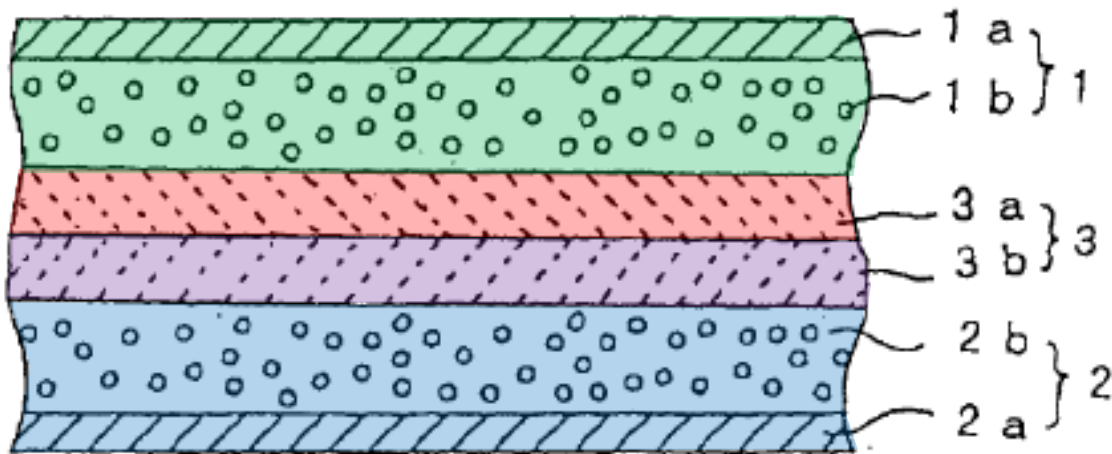
Petitioner believes formal construction is unnecessary, but notes that particle size measurements of micro-scale particles typically involves indirect measurement. EX1003, ¶113. For example, the '251 Patent describes the measurement of particle size using a “laser diffraction particle size analyzer (e.g. LA-920 manufactured by Horiba, Ltd.)” (EX1001, 6:49-54), which was consistent with measurements of other examples of such micro-scale particles in this art. *See, e.g.*, EX1006, [0049] (“number-average particle diameter measured by using a laser scattering particle size distribution meter (such as “LA-920” manufactured by HORIBA)”).

IX. REASONS FOR THE RELIEF REQUESTED UNDER 37 C.F.R. §§42.22(A)(2) AND 42.104(B)(4)

A. Ground 1 – Yoshida-Katayama Renders Obvious Claims 1-37

1. Yoshida

Yoshida discloses a battery with a nonaqueous electrolyte battery separator . EX1005, [0001], [0006]; EX1003, ¶¶45-53. The separator includes a [purple] heat-resistant layer and a [red] shutdown layer integrated into a multilayer structure between a [green] positive electrode and [blue] negative electrode.



EX1005, [0013], [0021], FIG. 1;⁴ EX1003, ¶46.

Yoshida's overarching aim is to improve safety at high temperatures by avoiding separator shrinkage that can cause internal shorts and thermal runaways.

EX1005, Abstract; EX1003, ¶47; *see also* §VII.

Yoshida explains that the “thermoplastic resin” of its shutdown layer can have a shutdown temperature—“of softening and shrink of the minute holes”—of 60°C to 150°C. EX1005, [0022].

Yoshida also explains that its heat-resistant layer includes fine particles having higher heat resistance than a thermoplastic resin of the shutdown layer. EX1005, [0007], [0009], [0011], [0013], [0015], [0017], [0020]; EX1003, ¶49.

⁴ All colorized figures herein are annotated.

These fine particles can include “[o]rganic or inorganic material such as silica, alumina, titanium oxide or clay.” EX1005, [0025].

Yoshida discloses that, within the heat-resistant layer, “[t]he average particle size of the[se] ... particles is preferably *at most 0.5 μm*,” because “particles having larger size than that do not efficiently *aggregate* and sufficient ion conductivity improvement of the electrolytic gel can not be expected when the aggregated particles are mixed.” EX1005, [0026] (emphasis added). Yoshida explains that “[t]he average particle size *of the aggregate* is preferably at least 0.2 μm to at most 2.0 μm,” because “[w]hen it is smaller than 0.2 μm, sufficient ion conductivity improvement of the electrolytic gel can not be expected when it is mixed” and “[w]hen it is larger than 2.0 μm, it is not preferable since film thickness becomes too large.” *Id.* (emphasis added). As indicated by Yoshida’s explanation that the 0.5 μm is important to allow the individual particles to aggregate, the distinction between individual particles and aggregated particles refers to the physical groupings of the smaller, individual particles to form larger, aggregated particles in the process of forming the second [heat-resistant] layer. EX1003, ¶51.

Yoshida discloses that its multi-layer separator improves safety because it reduces thermal shrinkage. EX1005, [0008], [0014]; EX1003, ¶52.

Yoshida does not describe layer thicknesses, porosity, particular shrinkage levels at elevated temperatures, or separator production; and includes limited examples of other details like positive active materials. EX1003, ¶53.

2. *Katayama*

Katayama discloses a nonaqueous electrolyte battery with a separator that includes a porous, resin shutdown layer and a heat-resistant layer including a filler, which separator layers can be integrated with each other and/or the electrodes. EX1006, [0002], [0015] (overall structure), [0022] (shutdown layer), [0023] (heat-resistant layer), [0073] (separator can be “integrated with the electrodes”); EX1003, ¶¶54-63. Katayama describes specific details about the materials and dimensions of the separator layers, including:

Katayama describes that the thickness of the first [shutdown] layer is 1-15 μm (preferably 3-10 μm), and the thickness of the second [heat-resistant] layer is 2-30 μm (preferably 4-20 μm). EX1006, [0082].

The thermal shrinkage rate of the separator is “1% or less” and “preferably is as close as 0% as possible.” EX1006; [0090]; EX1003; ¶57.

The overall separator has a porosity of 15-70%, and more preferably 20-60%. EX1006, [0083]. And the second [heat-resistant] separator layer has a porosity of 10-50%. EX1006, [0051], [0085].

In the heat-resistant layer, “the content of the filler . . . is preferably at least 50 vol. %, ... and further preferably at least 80 vol. % of the entire volume of the whole solid contents.” EX1006, [0059]; *see also id.*, [0125], [0156].

Katayama’s filler includes fine particles such as inorganic oxides. EX1006, [0053]-[0054]. To prevent short circuit, “plate-like particles are preferred.” EX1006, [0056]; EX1003, ¶60. Katayama discloses an average particle size of 1.5 μm or less. *See* EX1006, [0124], [0150], [0154].

Katayama’s shutdown layer includes a thermoplastic resin like a polyolefin. EX1006, [0027]; EX1003, ¶61.

Katayama also describes exemplary solvent-extraction methods of forming the microporous film of the shutdown layer, for example sequentially “applying a composition (a liquid composition such as a slurry or the like)” for either the shutdown layer or the heat-resistant layer, “subsequently drying at a predetermined temperature; and applying the other composition, followed by drying at a predetermined temperature.” EX1006, [0091].

For a battery including its separator, Katayama discloses examples of positive active materials for the positive electrode—e.g., LiMn_2O_4 , LiMnPO_4 , and LiFePO_4 —that exhibit a heat generation starting temperatures of 180°C or higher. EX1006, [0106]; EX1003, ¶63.

3. *Motivation to Combine*

At the outset, a POSITA would have been motivated to develop a heat-resistant separator to improve the safety of a battery at increased temperatures. *See* EX1005, [0004]; EX1001, 1:20-45 (describing “Background Art”); EX1003, ¶¶114-35; §VII.B. For example, Yoshida discloses the importance of a separator that can limit ion flow above a shutdown temperature, and prevent “shrink and generation of holes” as temperature increases. EX1005, [0004], [0005].

Yoshida describes an integrated, multilayer separator with shutdown and heat-resistant layers between positive and negative electrodes. EX1005, FIG. 1, [0013], [0021]. Katayama similarly discloses a battery separator with a heat-resistant layer and a shutdown layer. EX1006, [0002], [0015] (overall structure), [0022] (shutdown layer), [0023] (heat-resistant layer), [0073] (separator can be “integrated with the electrodes”); EX1003, ¶55. Katayama shares a similar focus of a “[battery] having excellent safety at a high temperature.” EX1006, Abstract; EX1003, ¶115.

Particularity given their similar structures and goals of improving battery safety at high temperatures, a POSITA would have been motivated look to Katayama for details of Yoshida’s components. Specifically, a POSITA would have been motivated to incorporate Katayama’s layer thicknesses, porosity, particle details, binder materials, and manufacturing processes as the details of implementing the

overall structure and benefits of Yoshida. EX1003, ¶116. A POSITA would have been motivated to incorporate these details from Katayama for several reasons. *Id.*

First, a POSITA would have been motivated to look to Katayama for details of Yoshida's components to accomplish Yoshida's goals of improved overall battery safety at increased temperatures, which Katayama also sought to achieve. *See* EX1005, Abstract, [0001], [0004]; EX1006, [0001] ("separator with ... excellent dimensional stability at a high temperature"); EX1003, ¶117. Yoshida does not explicitly disclose all details of its separator (*id.*); a POSITA would therefore have been motivated to look elsewhere for details of Yoshida's multi-layer separators and batteries. *Id.* As explained below, a POSITA would have recognized that Katayama's explanation of materials and details of a similar battery with similar separator structure would have been highly relevant to selecting details for, and understanding certain properties of, Yoshida's battery and its components. *Id.*

Second, a POSITA would have been motivated to look to Katayama for details of Yoshida's components to ensure acceptable performance. *Id.*, ¶118. A POSITA would have understood, and Katayama confirms, that Katayama's separator layer thicknesses and porosities, filler particles and vol. % in the heat-resistant layer could be used in Yoshida's battery to achieve desirable battery performance characteristics. *Id.* For example, Katayama explains how its properties—such as layer thicknesses (EX1006, [0081]-[0082]), porosity levels (*id.*, [0083]), and filler

vol. % for the heat-resistant layer (*id.*, [0058]-[0059])—are chosen to achieve desirable battery performance characteristics like energy density while improving safety at high temperatures. EX1003, ¶118.

Third, a POSITA would have been motivated to incorporate details from Katayama's structure because Katayama touts the benefits of doing so in a battery like Yoshida's with a multi-layer separator. EX1003, ¶119. For example, Katayama explains the benefits of its layer thicknesses (EX1006, [0081]-[0082]), porosity levels (*id.*, [0083]), filler vol. % for the heat-resistant layer (*id.*, [0058]-[0059]), binders (*id.*, [0068]-[0069]), and manufacturing processes (*id.*, [0089]). EX1003, ¶119.

Fourth, a POSITA would have found the incorporation of these details from Katayama to be a simple substitution because a POSITA was familiar with the properties of the materials as known in the art, and considered these materials to behave predictably. *Id.*, ¶120. Therefore, a simple substitution of the materials in this well-developed field would have been expected to yield predictable and desirable results—*e.g.*, improved heat resistance, a stated goal of Yoshida and Katayama. *Id.*

Thickness and Porosity. Yoshida does not offer any express guidance as to the thickness or porosity of its separator layers. EX1003, ¶121. A POSITA would have known that the thickness and porosity are two physical properties of that impact

the overall safety, heat-resistance, and electrical performance and would have been motivated to reduce thickness while maintaining sufficient physical strength. *See* Section VII.C; EX1006 at [0049] (“When the particle diameter is too large, the thickness of the first separator layer is increased, and thus the energy density of the electrochemical device is decreased”); EX1003, ¶121.

In the specific context of a separator with similar structure and materials, which achieves a similar goal of improved safety at high-temperatures, Katayama discloses desirable ranges for layer thicknesses and porosity. EX1003, ¶122. Thus, a POSITA would have been motivated to implement Yoshida’s multi-layer separator with Katayama’s separator-layer thicknesses and porosity levels. *Id.* Specifically, Katayama discloses a shutdown layer thickness of 1-15 μm (“more preferably” 3-10 μm), a heat-resistant layer thickness of 2-30 μm (“more preferably” 4-20 μm), and a total separator thickness of 3-30 μm (“more preferably” 5-20 μm). EX1006, [0081]-[0082]. Katayama explains that the lower ends of these narrower ranges are more preferable minimums for “further improving the effect of preventing a short circuit ..., securing the strength of the separator, and keeping the handleability,” and the upper ends of these narrower ranges are “more preferable” maximums for “further increasing the energy density” of the battery. *Id.*, [0082] (explaining desire to maximize energy density while minimizing risk of internal shorts and thermal runaway); EX1003, ¶122.

For porosity of the overall separator, Katayama teaches 15% or more and, “more preferably 20% or more ... for securing the liquid capacity for the electrolyte and improving the ionic permeability,” and, on the upper end limited to “70% or less, and more preferably 60% or less.” EX1006, [0083]. For porosity of the second [heat-resistant] layer, Katayama discloses a range of 10%-50%. *Id.*, [0051], [0085].

Thus, a POSITA would have viewed these ranges of thickness and porosity—details Yoshida does not expressly list—to have been desirable for balancing the desirable separator characteristics of short circuit protection, separator strength and handleability, energy density, and ionic permeability. EX1003, ¶124.

Filler Particles & Volume % in Heat-Resistant Layer. For the particles in its second porous [heat-resistant] layer 3b, Yoshida lists several possible materials (EX1005, [0025]) and the general limit that their average particle size “is preferably at most 0.5 μm ” (*id.*, [0026]), but does not include particle size distributions. EX1003, ¶125. Particularly in view of Yoshida’s cautions about aggregate sizing (EX1005, [0026]), a POSITA would have understood that particle size distribution could impact the formation of such aggregates. *Id.* As such, a POSITA would have been motivated to look to Katayama for particle details, including size distribution—that had been used successfully for heat-resistant layers. *Id.* Katayama’s Example 1 includes one such example: “silica (SiO_2) fine particles (average particle diameter: 0.4 μm ; particle size distribution: 0.3 to 0.7 μm).” EX1006, [0124]. Notably, the

silica material of these particles is called out by Yoshida as suitable for its heat-resistant layer (EX1005, [0025]), and the average particle size of these particles meets Yoshida's requirement that "the average particle size ... is preferably at most 0.5 μm " (*id.*, [0026]), which would confirm for a POSITA the suitability of these particles for use in Yoshida's heat-resistant layer. EX1003, ¶125.

Katayama also explains that the second layer is primarily included to prevent a short circuit, which "becomes difficult" if the filler content is too low. EX1005, [0059]. Katayama teaches the desirability of a filler content in the heat-resistant layer of "preferably at least 50 vol. %, ... and further preferably at least 80 vol. % of the entire volume of the whole solid contents." *Id.* Katayama's Example 1 also ties together these disclosed values of particle size distribution and vol. % with the separator porosity addressed above. *See* EX1006, [0124] (particle size distribution), [0125] (58% volume content of silica particles), and [0178] (Table 1: Example 1, second [heat-resistant] separator layer with 25% porosity).

Given the necessity of preventing shorts between electrodes, a POSITA would have recognized Katayama's teachings of minimum volume % for the filler particles, and the particular particle size distribution of Katayama's Example 1, as desirable options for Yoshida's heat-resistant layer. EX1003, ¶127.

Binder Materials. Yoshida explains that "any binder can be used if it dissolves [in] t[he] solvent but does not dissolve in the electrolytic solution of the

battery” (EX1005, [0027]), but does not offer further guidance. A POSITA thus would have been motivated to look to Katayama for binders that would improve desirable battery characteristics, such as heat resistance and handleability. *See* §VII.A; EX1003, ¶128. Katayama lists numerous organic binders, but explains that “a heat-resistant binder having a heat-resistant temperature of 150° C or higher is used preferably,” and that “binders with high flexibility such as EVA [ethylene-vinyl acetate copolymer], ethylene-acrylic acid copolymers, fluorine-based rubber, and SBR are preferable.” EX1006, [0068]-[0069]. Katayama also explicitly lists EVA as “having 20 mol % to 35 mol % of a structural unit derived from vinyl acetate.” *Id.*, [0068]. Katayama explains that the inclusion of a binder in the heat-resistant layer to secure the filler particles allows the “second separator [heat-resistant] layer [to] function[] to some extent as a base material of the separator, and thus the handleability is not a significant problem in the case where the separator is integrated with the electrodes.” *Id.*, [0073]. A POSITA therefore would have recognized Katayama’s “preferable” binder examples as desirable options for Yoshida’s separator. EX1003, ¶128.

Positive Active Materials. Yoshida does not offer guidance on selecting electrode materials, and mentions just one example of a positive active material for a cathode. EX1005, [0032]. A POSITA thus would have been motivated to look to Katayama for positive active materials that would improve desirable battery

characteristics, such as enhanced safety at elevated temperatures. EX1003, ¶129; §VII.D. Katayama discloses several examples of suitable positive active materials, noting that “there is no particular limitation.” EX1006, [0106]. Specific examples include LiFePO_4 and $\text{LiMn}_{1/3}\text{Ni}_{1/3}\text{Co}_{1/3}\text{O}_2$. *Id.* Katayama discloses that any of its examples can be used, such that a POSITA would have viewed any of Katayama’s specific examples to be suitable options given Katayama’s stated benefit of “excellent safety at high temperature.” EX1006, Abstract; §VII.D; EX1003, ¶129.

Additionally, a POSITA would have been familiar with the properties of such positive active materials, including their relative heat generation starting temperatures. EX1003, ¶130. A POSITA would have recognized these two particular examples as (a) having previously been used successfully in nonaqueous batteries, and (b) having higher heat generation starting temperatures. *Id.* A POSITA would have also recognized that a higher heat generation starting temperature can improve battery safety by increasing the temperature at which the positive active material adds further energy (heat) to a battery whose temperature is already increasing, for example due to external short circuit or overcharging. *See* §VII.D; EX1003, ¶130.

Ultimately, a POSITA would have been motivated to use a proven, positive active material with a relatively high heat generation starting temperature, and would have expected Katayama’s disclosed materials to satisfy this criteria given

Katayama's use of them in batteries with "excellent safety at high temperature."
EX1006, Abstract; EX1003, ¶131.

A POSITA would therefore have viewed LiFePO_4 and $\text{LiMn}_{1/3}\text{Ni}_{1/3}\text{Co}_{1/3}\text{O}_2$ as desirable material options for Yoshida's positive electrode. EX1003, ¶132.

Separator Production. Yoshida does not discuss the process for forming the first [shutdown] layer of its separator (*see* EX1005, [0022]), mentioning in its examples only one commercially available film (*see id.*, [0031], [0037], [0039], [0042], [0045], [0048]). A POSITA therefore would have been motivated to look to Katayama for particular manufacturing processes for forming its shutdown layer (and overall separator) to meet Yoshida's goal of improved overall battery safety at increased temperatures, which Katayama also sought to achieve, while achieving layer thicknesses Yoshida teaches for desirable characteristics like energy density, shutdown performance, and handleability. EX1003, ¶133. As explained in Section IX.A.2 above, Katayama discloses manufacturing both separator layers using wet, solvent-extraction processes.

A POSITA would have known there are two primary categories of processes for manufacturing films for lithium-ion cells—a dry process and a wet process, with potential tradeoffs in performance between the two. EX1003, ¶134; §VII.E. And Katayama explicitly describes a benefit of using its own solvent-extraction methods, particularly over a conventional drawn film like that used in Yoshida's examples.

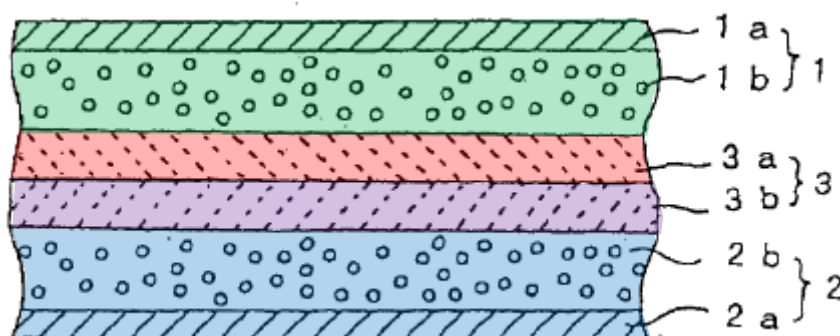
EX1006, [0089]; EX1003, ¶134. In particular, Katayama explains that its two-layer separator produced “without applying intensive stress unlike a conventional separator formed of a porous film of PE, there is little or no residual stress after the production, and thermal shrinkage is less likely to occur also due to the presence of the second separator layer in that thermal shrinkage is less likely to occur.” EX1006, [0089]. Consistent with Yoshida’s teachings (EX1005, Abstract), a POSITA would have recognized that minimizing shrinkage was desirable to avoid internal shorting at elevated temperatures, and therefore would have viewed Katayama’s solvent-extraction methods of producing both separator layers—shutdown layer 3a and heat-resistant layer 3b—as desirable options for making Yoshida’s overall separator structure. EX1003, ¶134.

Expectation of Success. In addition to the explicit teachings of Yoshida, Katayama would have led a POSITA to reasonably expected the above-described aspects of Katayama to be effective in implementing the battery of Yoshida, i.e., a battery “having excellent safety at a high temperature.” EX1006, Abstract; EX1003, ¶135. Not only does Katayama explain the desirable benefits of its features (explained above), but the field of battery technology was well-developed with particular understanding of the functionality of these features (§VII), such that a POSITA would have had an independent understanding that would have led to a reasonable expectation that the above-described features of Katayama would

function as Katayama described when incorporated into the highly similar context of Yoshida's battery. EX1003, ¶135.

4. *Yoshida in view of Katayama*

The combined Yoshida-Katayama structure includes a [purple] heat-resistant layer and a [red] shutdown layer integrated into a *multilayer structure* interposed between a [green] positive electrode and [blue] negative electrode.



EX1005, [0013], [0021], FIG. 1; EX1003, ¶¶136-44.

Shutdown Layer. In the separator of the Yoshida-Katayama battery, the first, shutdown layer 3a would include a “thermoplastic resin” and have a shutdown temperature—“of softening and shrink of the minute holes”—of 60°C to 150°C. EX1005, [0022]; EX1003, ¶137. While Yoshida expressly discloses shutdown temperatures as high as 150°C, for the additional reasons explained below with Limitation 1[i], it would have been obvious for a POSITA to select the materials of shutdown layer 3a to have a shutdown temperature of 135°C to 150°C. For the

reasons explained above in Section IX.A.3, shutdown layer 3a would be formed via Katayama's solvent-extraction method. EX1003, ¶138.

Heat-Resistant Layer. For the reasons explained above in Section IX.A.3, heat-resistant second layer 3b would be constituted by at least 50 vol. % of the silica particles of Katayama's Example 1 (EX1006, [0059], [0124]) and any of the binders Katayama discloses as preferred—EVA, ethylene-acrylic acid copolymers, fluorine-based rubber, or SBR (EX1006, [0068]-[0069])—and would have a porosity of 10-50% (EX1006, [0051], [0085]). EX1003, ¶139. For the reasons explained above in Section IX.A.3, heat-resistant layer 3b would be formed via Katayama's solvent-extraction method. EX1003, ¶140.

Thicknesses of Layers & Overall Separator. For the reasons explained above in Section IX.A.3, shutdown layer 3a would have a thickness of 3-10 μm , heat-resistant layer 3b would have a thickness of 4-20 μm , and the overall separator would have a combined thickness of 5-30 μm (more preferably 5-20 μm). EX1006, [0081]-[0082]; EX1003, ¶141.

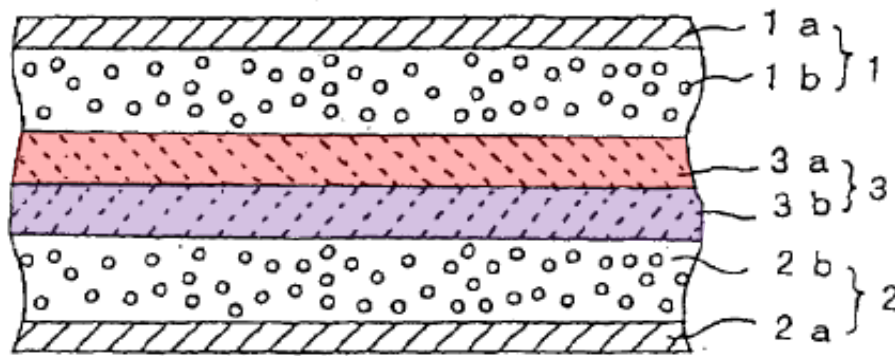
Porosity of Overall Separator. For the reasons explained above in Section IX.A.3, the porosity of the overall separator would be from 20% to 60%. EX1006, [0083]; EX1003, ¶142.

Positive Active Material. For the reasons explained above in Section IX.A.3, Yoshida-Katayama renders obvious the use of any of the positive active materials disclosed in Katayama, including LiFePO_4 and $\text{LiMn}_{1/3}\text{Ni}_{1/3}\text{Co}_{1/3}\text{O}_2$. EX1003, ¶143.

5. *Element-by-Element Analysis*

Limitation 1[p]: “A battery separator comprising:”

Without conceding that the preamble limits, Yoshida-Katayama renders obvious a battery separator. EX1003, ¶145. As explained in Sections IX.A.3-IX.A.4, the Yoshida-Katayama structure is a nonaqueous electrolyte battery having a multilayer separator with a [purple] heat-resistant layer and a [red] shutdown layer.



EX1005, [0002]-[0003], [0020]-[0023], FIG. 1; EX1003, ¶145.

Limitation 1[a]: “heat-resistant fine particles; and”

Yoshida-Katayama renders obvious heat-resistant fine particles. EX1003, ¶¶146-47. As explained above in Sections IX.A.3-IX.A.4, the Yoshida-Katayama structure includes a [purple] heat-resistant layer 3b (EX1005, [0021], [0023]-[0024]) that includes the silica particles of Katayama’s Example 1. EX1006, [0124]; EX1003, ¶147. These particles are heat-resistant. EX1006, Abstract (filler is “heat-

resistant”), [0025] (same), [0054] (silica an example of filler); EX1005, [0025] (listing silica as example of fine particles having “high heat resistance”).

Limitation 1[b]: “a thermoplastic resin,”

Yoshida-Katayama renders obvious a thermoplastic resin. EX1003, ¶¶148-49. As explained in Sections IX.A.3-IX.A.4, the Yoshida-Katayama structure includes a [red] shutdown layer 3a, of which “the main component” is a “thermoplastic resin.” EX1005, [0022]; EX1003, ¶149.

Limitation 1[c]: “wherein the heat-resistant fine particles along with a binder constitute a heat-resistant layer,”

Yoshida-Katayama renders obvious a heat-resistant layer formed of heat-resistant fine particles and a binder. EX1003, ¶¶150-51. As explained above in Sections IX.A.3-IX.A.4 and for Limitation 1[a], the Yoshida-Katayama structure includes a [purple] heat-resistant layer 3b (EX1005, [0021], [0023]-[0024]) that includes the silica fine particles of Katayama’s Example 1 (EX1006, [0124]) and a binder (EX1005, [0027]; EX1006, [0068]-[0069]). EX1003, ¶150.

Limitation 1[d]: “the thermoplastic resin constitutes a shutdown layer formed of a heat-shrinkable microporous film,”

Yoshida-Katayama renders obvious a thermoplastic resin that acts as a shutdown layer and is formed of a heat-shrinkable microporous film. EX1003, ¶¶152-53. As explained above in Sections IX.A.3-IX.A.4, the Yoshida-Katayama

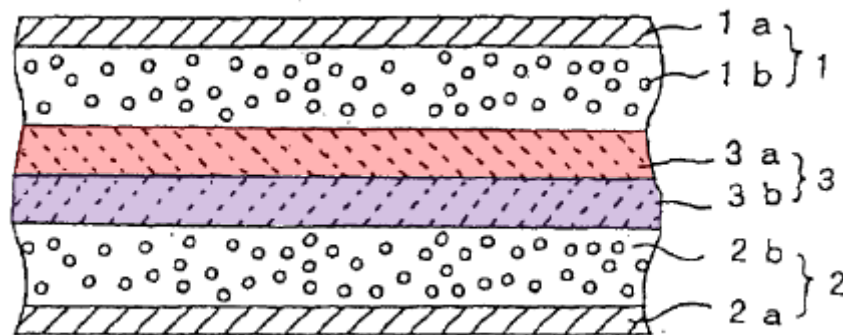
structure includes a [red] shutdown layer 3a that includes a “thermoplastic resin” and has a shutdown temperature—“of softening and shrink of the minute holes”—of 60°C to 150°C. EX1005, [0022], [0036] (“When the battery was heated to 120°C . . . there was an effect that melting of the polypropylene part of the separator 3 (the first porous layer 3a) *shut down ion conductivity*.”), [0020]; EX1003, ¶152.

For the reasons explained above in Section IX.A.3, shutdown layer 3a would be formed via Katayama’s solvent-extraction method and would therefore be a porous film. EX1006, [0021] (“porous film”); EX1003, ¶153; *see also* EX1005, [0020] (“separator ... comprises a porous film containing these thermoplastic resins...”); EX1003, ¶153. Yoshida also explains that the pores are “minute holes” (EX1005, [0020]) and a nonaqueous battery requires “a [separator] layer between the both electrodes through which lithium ions can move and which has no electric conductivity.” *Id.*, [0003]. A POSITA would have understood that—in the context of a separator layer on the order of 20 µm, such “minute holes” would necessarily be micropores, or the shutdown layer would not be able to perform its shutdown function because initial melting of the thermoplastic would not necessarily close the pores. EX1003, ¶153. Indeed, a POSITA would have understood that a general requirement for Lithium-ion battery separators was for the pores to be smaller than 1 µm. *See, e.g.*, EX1013, 4429 (Table 5), 4428 (“submicrometer pore size”).

Finally, the thermoplastic resin is heat-shrinkable. EX1005, [0020]; EX1003, ¶154. Yoshida describes the resin as having a “*temperature of softening and shrink* of the minute holes.” EX1005, [0022], [0020]; Limitation 1[b]; EX1003, ¶154.

Limitation 1[e]: “the heat-resistant layer and the shutdown layer are integrated into a multilayer structure,”

Yoshida-Katayama renders obvious heat-resistant and shutdown layers being integrated into a multilayer structure. EX1003, ¶155. As shown in Yoshida’s FIG. 1, a [purple] heat-resistant layer 3b and a [red] shutdown layer 3a are integrated into a multilayer structure.



EX1005, FIG. 1; EX1003, ¶155. “Numeral 3 indicates a separator ... obtained by *laminating a first porous layer 3a ... onto a second porous layer 3b ...*” EX1005, [0021]; EX1003, ¶155.

Limitation 1[f]: MJ :“the shutdown layer has a thickness A (μm) of 5 to 30, the heat-resistant layer has a thickness B (μm) of 1 to 10, a sum of A and B is 6 to 23, and a ratio A/B is 1/2 to 4,”

Yoshida-Katayama renders obvious shutdown and heat-resistant layers with the claimed thicknesses and thickness ratios. EX1003, ¶¶156-66. As explained above in Sections IX.A.3-IX.A.4, Yoshida-Katayama renders obvious the shutdown layer 3a having a thickness (A) of 3-10 μm, the heat-resistant layer 3b having a thickness (B) of 4-20 μm, and the overall separator having a combined thickness (sum of A and B) of 7-30 μm. EX1003, ¶156; EX1006, [0081]-[0082].

Importantly, “[a] prior art reference that discloses an overlapping ... range” creates a “prima facie case of anticipation,” of that range even “where the prior art range only partially or slightly overlaps with the claimed range.” *Genentech, Inc. v. Hospira, Inc.*, 946 F.3d 1333, 1338 (Fed. Cir. 2020) (affirming that claimed range of “about 10°C to about 18°C” was anticipated by prior art “18-25°C” range).

For the limitation that $5 \leq A \leq 30 \mu\text{m}$,⁵ Yoshida-Katayama rendered obvious that the thickness (A) of shutdown layer 3a is 3-10 μm. EX1006, [0081]-[0082];

⁵ Despite reciting $5 \leq B \leq 30$, the $A + B \leq 23$ limitation means claim 1 precludes A from exceeding 22 because the claim also requires that $A \geq 1$. EX1003, n.3.

EX1003, ¶158. Most—roughly 71%—of this “preferred” range ($((10-5)/(10-3) = 71\%)$) overlaps a significant portion of the claimed range.

For the limitation that $1 \leq B \leq 10 \mu\text{m}$, Yoshida-Katayama renders obvious that the thickness (B) of heat-resistant layer 3b is 4-17 μm . EX1006, [0081]-[0082]; EX1003, ¶159. Nearly half—roughly 46%—of this “preferred” range falls within the claimed range ($((10-4)/(17-4) = 46\%)$).

For the limitation that $6 \leq A+B \leq 23$, the preferred minimum thicknesses of 3 μm for the shutdown layer and 4 μm for the heat-resistant layer results in a minimum preferred sum of A and B of 7 μm , and the preferred maximum thicknesses of 10 μm for the shutdown layer and 20 μm for the heat-resistant layer results in a maximum preferred sum of A and B of 30 μm . *Id.*, ¶160. As such, the preferred range of A + B is 7 to 30 μm , with corresponding ratios A/B of 3/4 at the minimum preferred layer thicknesses to 1/2 at the max preferred layer thicknesses. *Id.* Thus, all of the disclosed preferred range of ratios falls within the claimed range of ratios, and the majority—roughly 70%—of the disclosed preferred range of the sum of A and B ($((23-7)/(30-7) = 70\%)$) overlaps the claimed range of 6 to 23. *Id.*

Moreover, Katayama discloses that the separator should have an overall “thickness of ... more preferably not more than 20 μm . EX1006, [0081]. A POSITA therefore would have been guided by Katayama to limit the total separator thickness to 20 μm . EX1003, ¶161. Given the change in A/B aspect ratio from 3/4 (0.75) at

the minimum preferred layer thicknesses to 1/2 (0.5) at the maximum preferred layer thicknesses, a POSITA would have inferred that Katayama's preferred aspect ratio at a total separator thickness of 20 μm could be simply interpolated as follows:

$$A/B_{20\mu\text{m}} = 0.5 + \left((0.75 - 0.5) \times \frac{(20 - 7)}{(30 - 7)} \right) = 0.64$$

Id. Thus, a POSITA would have reasonably inferred that a desirable aspect ratio at the maximum preferred total thickness of 20 μm would have been 0.64, which results in $A = 7.8 \mu\text{m}$, and $B = 12.2 \mu\text{m}$. *Id.*, ¶162. Applying these as the upper ends of Katayama's preferred ranges results in $3 \leq A \leq 7.8 \mu\text{m}$, and $4 \leq B \leq 12.2 \mu\text{m}$. *Id.* With this approach of $A/B = 0.64$, most—roughly 58%—of this most-preferred A range falls within the claimed range $((7.8-5)/(7.8-3) = 58\%)$, as does the aspect ratio (0.64), the corresponding B values (7.81 μm to 12.2 μm), and the sum of $A+B$ (from 12.81 μm to 20 μm). *Id.*

Even applying the more-conservative maximum-thickness A/B aspect ratio (1/2) to the maximum preferred total thickness of 20 μm results in $A = \sim 6.67 \mu\text{m}$, and $B = \sim 13.33 \mu\text{m}$. *Id.*, ¶163. Applying these as the upper ends of Katayama's preferred ranges results in $3 \leq A \leq 6.67 \mu\text{m}$, and $4 \leq B \leq 13.33 \mu\text{m}$. *Id.* With this approach of $A/B = 0.50$, a significant portion—roughly 35%—of this most-preferred A range falls within the claimed range $((6.67-5)/(6.67-3) = 35\%)$, as does the aspect

ratio (0.5), the corresponding B values (10 μm to 13.33 μm), and the sum of A+B (from 15 μm to 20 μm). *Id.*

Likewise, applying the minimum-thickness A/B aspect ratio (3/4) to the maximum preferred total thickness of 20 μm results in $A = 8.57 \mu\text{m}$, and $B = 11.43 \mu\text{m}$. Applying these as the upper ends of Katayama's preferred ranges results in $3 \leq A \leq 8.57 \mu\text{m}$, and $4 \leq B \leq 11.43 \mu\text{m}$. *Id.*, ¶164. With this approach of $A/B = 0.75$, most—roughly 64%—of this most-preferred A range falls within the claimed range ($((8.57-5)/(8.57-3) = 64\%)$), as does the aspect ratio (0.75), the corresponding B values (6.67 μm to 11.43 μm), and the sum of A+B (from 11.67 μm to 20 μm). *Id.*

Finally, varying the respective layer thicknesses within the limited preferred ranges set forth by Katayama would have involved no more than routine optimization of only two thicknesses that would have inevitably included values that met all aspects of this Limitation 1[f]. *Id.*, ¶165.

Thus, regardless of the approach for which PO might argue, Yoshida-Katayama renders obvious particular layer thicknesses of each of A and B, and corresponding total thicknesses of A and B and aspect ratio A/B, significant portions of which overlap those of Limitation 1[f]. *Cf. Genentech*, 946 F.3d at 1338; *see also Wm. Wrigley Jr. Co. v. Cadbury Adams USA LLC*, 683 F.3d 1356, 1362 (Fed. Cir.

2012) (finding anticipation where the prior art reference “discloses component amounts within the ranges claimed”); EX1003, ¶166.

Limitation 1[g]: “a content of the heat-resistant fine particles in the heat-resistant layer is 50 vol % or more of a total volume of components in the heat-resistant layer,”

Yoshida-Katayama renders obvious a content of heat-resistant fine particles in the heat-resistant layer of a separator is 50 vol % or more of a total volume of components in the heat-resistant layer. EX1003, ¶¶167-71. As explained above in Sections IX.A.3-IX.A.4, the silica particles of Katayama’s Example 1 would have constituted at least 50 vol. % of the total volume of components in heat-resistant second layer 3b. EX1006, [0059], [0124]; EX1003, ¶167.

Limitation 1[h]: “a proportion of particles with a particle size of 0.2 μm or less in the heat-resistant fine particles is 10 vol % or less and a proportion of particles with a particle size of 2 μm or more in the heat-resistant fine particles is 10 vol % or less, and”

Yoshida-Katayama renders obvious the heat-resistant layer having particles with this size distribution. EX1003, ¶¶172-73. As explained above in Sections IX.A.3-IX.A.4 and for Limitation 1[c], the Yoshida-Katayama structure includes a [purple] heat-resistant layer 3b (EX1005, [0021], [0023]-[0024]) that includes the silica fine particles of Katayama’s Example 1 (EX1006, [0124]) and a

binder (EX1005, [0027]; EX1006, [0068]-[0069]). EX1003, ¶172. These particles are “silica (SiO₂) fine particles (average particle diameter: 0.4 μm; particle size distribution: 0.3 to 0.7 μm).” EX1006, [0123].

A POSITA would have understood this disclosure to mean that the D10 value is 0.3 μm, the D50 value is 0.4 μm, and the D90 value is 0.7 μm. What this means is that 10% of the particles had a particle size of less than 0.3 μm, and 90% of the particles had a particle size less than 0.7 μm. EX1003, ¶173. Particle size distribution is common described as D10, D50, and D90, wherein 10% of the particles are lower than D10, the average is D50, and 90% of the particles are smaller than D90. *Id.* A POSITA would understand such a disclosure to mean that 0.3 μm is D10 and 0.7 μm is D90.. *Id.* Thus, a POSITA would have understood from Katayama’s disclosure that a proportion of particles with particle size of 0.3 μm or less is 10 vol. % or less (i.e., necessarily *less than* 10 vol. % have a particle size of 0.2 μm or smaller), and a proportion of particles with particle size of 0.7 μm or more is 10 vol. % or less (necessarily *less than* 10 vol. % have a particle size of 0.7 μm or larger); which is within the limits of Limitation 1[h].

Limitation 1[i]: “a shutdown is effected in a range of 135° C. to 150° C.”

Yoshida-Katayama renders obvious a separator with a “shutdown effected in a range of 135°C. to 150°C.” EX1003, ¶129. As explained above in Sections IX.A.3-IX.A.4, Yoshida-Katayama renders obvious a shutdown layer 3a

with a shutdown temperature—“of softening and shrink of the minute holes”—of 60°C to 150°C. EX1005, [0022]; EX1003, ¶¶174-78. This range overlaps the claimed range. *Cf. Genentech*, 946 F.3d at 1338; *Wm. Wrigley Jr. Co.*, 683 F.3d at 1362; EX1003, ¶174.

Additionally, a POSITA would have recognized Yoshida’s disclosure as an express indication that shutdown temperatures throughout the entire range would be desirable in different implementations of Yoshida’s battery. EX1003, ¶175; *see also* EX1009, 38, Figure 23 (shutdown temperatures of commercially available separators of 131°C, 139°C, 143°C). With active materials having higher heat generation starting temperatures like 229°C and a stable heat-resistant layer 3b, a POSITA would have found it desirable to for the shutdown layer 3a to have a shutdown temperature at the upper end of Yoshida’s disclosed range—i.e., 135°C to 150°C. EX1003, ¶175. In such implementations, with other battery materials that can reliably survive temperatures in excess of 180°C (*see, e.g.*, EX1006, [0075]), a POSITA would have recognized that a shutdown temperature lower than 135° C would be relatively inefficient in that it would melt and permanently disable a battery cell at an unnecessarily low temperature . EX1003, ¶175. Typically materials with low shutdown temperature have lower shrinkage temperatures. *Id.*

On the other hand, with other battery materials that can reliably survive temperatures in excess of 180°C (*see, e.g.*, EX1006, [0075]), a POSITA would have

recognized that a higher shutdown temperature such as 140°C would have desirably allowed for increased charging rates (and associated higher temperatures), use in higher-temperature environments, or both. EX1003, ¶176; *see also, e.g.*, EX1018, Table 1 (listing 138°C and 145°C separator shutdown temperatures). Indeed, even with what PO may see as a choice to pursue relatively lower shutdown temperatures, Katayama discloses three examples—Examples 5 and 11, and Comparative Example 3—having shutdown temperatures of 135°C and 137°C based on the unique composition of the shutdown layer. EX1006, Table 3; EX1003, ¶176.

A POSITA would have also reasonably expected success in implementing shutdown temperatures within the range disclosed by Yoshida. EX1003, ¶177. First, Yoshida expressly discloses such temperatures and materials that could be configured to achieve them. EX1005, [0022]. Second, Katayama includes examples of separators with shutdown temperatures within the claimed range—i.e., 135°C and 137°C. EX1006, [0184], Table 3. And, third, a POSITA would have independently understood that shutdown temperature was adjustable by selecting and/or adjusting the composition of the thermoplastic resin (e.g., vol %, ratio, and density). *See* §VII.C; EX1003, ¶177.

Thus, Yoshida-Katayama renders obvious a shutdown layer with a shutdown temperature in the range of 135°C to 150°C. EX1003, ¶178.

Limitation 2: “The battery separator according to claim 1, wherein a thermal shrinkage ratio in a width direction is 10% or less at 200° C.”

Yoshida-Katayama renders obvious a separator with a thermal shrinkage ratio in a width direction of 10% or less at 200°C. EX1003, ¶¶179-181. As explained above in Sections IX.A.3-IX.A.4 and for Limitation 1[g], the content of the silica particles in heat-resistant layer 3b of the Yoshida-Katayama structure would have included “preferably at least 50 vol. %, ... of the entire volume of the whole solid contents.” EX1006, [0059]. Additionally, in at least some configurations, a POSITA would have been motivated to “further preferably” increase this particle content at least 80 vol. % to further prevent the risk of a short circuit. *Id.*; EX1003, ¶179.

Such a heat-resistant layer inherently would have had a thermal shrinkage ratio in a width direction of 10% or less at 200°C. EX1003, ¶180. First, 80 vol. % or more of the heat-resistant layer 3b would have been defined by the particles of Katayama’s Example 1 (*see* Limitation 1[h]) that are silica (SiO₂), which are a ceramic. EX1003, ¶180. Such ceramics were known to have very low thermal shrinkage ratios of 1% or less *See, e.g.*, EX1007, [0051]; EX1003, ¶180. And a heat-resistant layer formed by Katayama’s solvent extraction method (*see* Sections IX.A.3-IX.A.4), even when integrated with a polyolefin shutdown layer, would inherently exhibit thermal shrinkage of 10% or less at 200°C. EX1003, ¶180.

The '251 Patent itself confirms that this Yoshida-Katayama separator would inherently exhibit a thermal shrinkage ratio of less than 10% at 200°C. *Id.*, ¶181. For example, Table 1 of the '251 Patent lists thermal shrinkage ratios at 200°C of 2% and 1% for Examples 1 and 4, respectively. EX1001, 18:15-35, Table 1.

Example 4 has ceramic particle content of 91 vol. % boehmite, a binder content of 9 vol. % of SBR, and a heat-resistant layer thickness of 6 µm, together yielding a thermal shrinkage ratio of 1% at 200°C. *Id.* Therefore, a POSITA would have expected that at roughly the midpoint of a particle content range of 80-100 vol. %, the shrinkage would be 1% based on Katayama's teachings and confirmed by the '251 Patent. EX1003, ¶181. Example 1 has a significantly higher particle content of roughly 95 vol. % (based on 4000 g of boehmite at ~3 g/cm³ (*see* EX1006, [0131]), and 80 g of acrylic resin binder at ~1.2 g/cm³ (*see* EX1006, [0125])) and a shrinkage ratio of 2%. EX1003, ¶181.

A POSITA would have understood that the heat-resistant layer resists shrinkage of the attached shutdown layer, such that a solids content as high as 95% could increase shrinkage, as reflected in Example 1 relative to Example 4, because it leaves very little binder to resist relative movement between the particles. *Id.* A POSITA also would have understood that increasing binder relative to that 5 vol. % level would—to a point—resist relative movement between particles and thereby decrease shrinkage, as reflected in Example 4 relative to Example 1. *Id.* A POSITA

would have expected the further increasing content of binder relative to the 9 vol. % of Example 4 would decrease shrinkage, at least to 20 vol. % binder and 80 vol. % particles, consistent with Katayama's "more preferred" threshold of 80 vol. % particles. *Id.* Conservatively, a POSITA therefore would have expected that shrinkage would be less than or equal to 2% when particle content at least 80 vol. %. *Id.*

Based on Katayama's teachings that this low shrinkage prevents short circuits and improves the safety of the electrochemical device at a high temperature (EX1006; [0090]), and the knowledge (confirmed by Katayama) that solids content impacts shrinkage, a POSITA would have been motivated to minimize shrinkage by optimizing the particle content within Katayama's preferred range of 80 vol. %, and—as confirmed by the '251 Patent's own measured data—that optimization would necessarily have yielded a two-layer separator with (1) a thermoplastic resin, microporous film shutdown layer, and (2) a heat-resistant layer with ≥ 80 vol. % ceramic that necessarily would have exhibited a thermal shrinkage ratio of less than 2% (well under 10%). EX1003, ¶182.

Limitation 3: “The battery separator according to claim 1, wherein the content of the heat-resistant fine particles in the heat-resistant layer is 80 vol % or more of the total volume of components in the heat-resistant layer.”

Yoshida-Katayama renders obvious a separator with a heat-resistant layer having this particle content. EX1003, ¶183; *see* Limitation 2 (80 vol. %).

Limitation 4: “The battery separator according to claim 1, wherein the heat-resistant fine particles are inorganic fine particles.”

Yoshida-Katayama renders obvious a battery separator with heat-resistant inorganic fine particles. EX1003, ¶¶184. As explained above in Sections IX.A.3-IX.A.4 and for Limitation 1[h], the Yoshida-Katayama structure includes a [purple] heat-resistant layer 3b (EX1005, [0021], [0023]-[0024]) that includes the silica fine particles of Katayama’s Example 1 (EX1006, [0124]). EX1003, ¶184. These “silica fine particles ... contain 25 vol % of plate-like particles.” EX1006, [0126]. A POSITA would have recognized, and Katayama confirms, that silica (SiO₂) is inorganic. EX1006, [0054]; EX1003, ¶184.

Limitation 5: “The battery separator according to claim 4, wherein the inorganic fine particles include fine particles of at least one selected from the group consisting of alumina, silica, BaTiO₃, boehmite, zeolite, and kaoline.”

Yoshida-Katayama renders obvious a separator with fine particles of silica. EX1003, ¶185. *See* Limitation 4 (silica).

Limitation 6: “The battery separator according to claim 1, wherein the heat-resistant fine particles include plate-like particles.”

Yoshida-Katayama renders obvious a separator with heat-resistant fine particles that include plate-like particles. EX1003, ¶186. As explained above in Sections IX.A.3-IX.A.4 and for Limitation 1[h], the Yoshida-Katayama structure includes a [purple] heat-resistant layer 3b (EX1005, [0021], [0023]-[0024]) that includes the silica fine particles of Katayama’s Example 1 (EX1006, [0124]) and a binder (EX1005, [0027]; EX1006, [0068]-[0069]). EX1003, ¶186. These “silica fine particles ... contain 25 vol % of plate-like particles.” EX1006, [0126].

Limitation 7: “The battery separator according to claim 1, wherein the heat-resistant layer has a thickness of 2 μm to 6 μm.”

Yoshida-Katayama renders obvious a separator with a heat-resistant layer that has a thickness of 2 μm to 6 μm. EX1003, ¶187. As explained above in Sections IX.A.3-IX.A.4 and for Limitation 1[f], Yoshida-Katayama renders obvious the heat-resistant layer 3b having a thickness of 4-20 μm. EX1006, [0081]-[0082]; EX1003, ¶187. This “preferred” range overlaps the claimed range. *Cf. Genentech*, 946 F.3d at 1338; *Wm. Wrigley Jr. Co.*, 683 F.3d at 1362; EX1003, ¶187.

Limitation 8: “The battery separator according to claim 1, wherein the thermoplastic resin includes polyolefin.”

Yoshida-Katayama renders obvious a separator with thermoplastic resin that includes polyolefin. EX1003, ¶¶188-89. *See* Limitation 1[b] (thermoplastic resin). Yoshida discloses “a *polyolefin* such as polypropylene or polyethylene” as an example of its thermoplastic resin. EX1005, [0022]; EX1003, ¶188.

Limitation 9: “The battery separator according to claim 1, wherein the heat-resistant fine particles have an average particle size of 1.5 μm or less.”

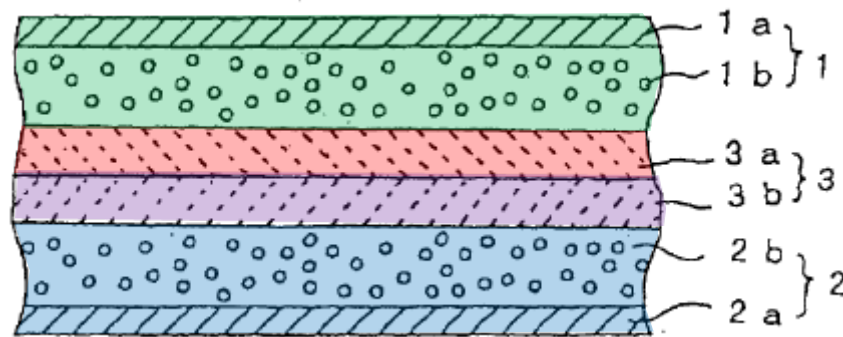
Yoshida-Katayama renders obvious a separator with heat-resistant fine particles having an average particle size of 1.5 μm or less. EX1003, ¶190. As explained above in Sections IX.A.3-IX.A.4 and for Limitation 1[c], the Yoshida-Katayama structure includes a [purple] heat-resistant layer 3b (EX1005, [0021], [0023]-[0024]) that includes the silica fine particles of Katayama’s Example 1 (EX1006, [0124]). EX1003, ¶190. These particles have an “average particle diameter: 0.4 μm” (EX1006, [0123]) which is measured using the same “LA-920” analyzer used in the ’251 Patent itself. *Compare id.*, [0049] *with* EX1001, 6:49-53.

Limitation 10[p]: “A nonaqueous electrolyte battery comprising:”

See Limitation 1[p]; EX1003, ¶191.

Limitation 10[a]: “a positive electrode having a positive active material capable of intercalating and deintercalating a lithium ion;”

Yoshida-Katayama renders obvious a positive electrode having a positive active material capable of intercalating and deintercalating a lithium ion. EX1003, 192. Yoshida’s battery includes a [green] “positive electrode 1.” EX1005, FIG. 1, [0021]; EX1003, ¶146. A POSITA would have understood that a positive electrode in a lithium secondary battery necessarily is inherently capable of deintercalating and intercalating lithium ions, or else the battery would not function. EX1003, ¶192.



EX1005, FIG. 1; EX1003, ¶192.

Limitation 10[b]: “a negative electrode having a negative active material capable of intercalating and deintercalating a lithium ion;”

Yoshida-Katayama renders obvious a negative electrode having a negative active material capable of intercalating and deintercalating a lithium ion. EX1003, ¶193. Yoshida’s battery includes a [blue] “negative electrode 2.” EX1005, FIG. 1, [0021]; EX1003, ¶193. A POSITA would have understood that a negative electrode

in a lithium secondary battery necessarily is inherently capable of intercalating and deintercalating lithium ions, or else the battery would not function. EX1003, ¶193.

Limitation 10[c]: “a separator interposed between the positive electrode and the negative electrode; and”

Yoshida-Katayama renders obvious a separator interposed between the positive electrode and the negative electrode. EX1003, ¶194. Yoshida’s battery includes “a [red/purple] separator [3] interposed between the positive electrode 1 and the negative electrode 2.” EX1005, [0021]; EX1003, ¶194.

Limitation 10[d]: “a nonaqueous electrolyte,”

Yoshida-Katayama renders obvious a nonaqueous electrolyte. EX1003, ¶195. Yoshida discloses a “non-aqueous [electrolyte] solution is filled to constitute the ion conductive layer.” EX1005, [0003]; EX1003, ¶195.

Limitation 10[e]: “wherein a heat generation starting temperature of the positive electrode is 180° C. or higher, and”

Yoshida-Katayama renders obvious a positive electrode with a heat generation starting temperature of 180°C or higher. EX1003, ¶196. As explained above in Sections IX.A.3-IX.A.4, Yoshida-Katayama render obvious at least the use LiFePO_4 and $\text{LiMn}_{1/3}\text{Ni}_{1/3}\text{Co}_{1/3}\text{O}_2$ for Yoshida’s positive electrode 1. EX1003, ¶196. These two materials each inherently have a high heat generation starting temperature of 229°C. *See, e.g.*, EX1001, 14:24-26 (Example 1 including $\text{LiCo}_{0.33}\text{Ni}_{0.33}\text{Mn}_{0.33}\text{O}_2$

as positive active material), 15:47-49 (Example 3 including LiFePO_4 as positive active material), 18:15-30, Table 1 (listing heat generation starting temperature of 229°C for each of Example 1 and Example 3).

Limitation 10[f]: “wherein the separator is the battery separator according to claim 1.”

Yoshida-Katayama renders obvious including the separator of claim 1 in the nonaqueous battery of claim 10. EX1003, ¶¶197-98. As explained above, Yoshida-Katayama renders obvious a battery separator as claimed in claim 1, particularly in the context of a nonaqueous battery such as that of claim 10. *See* Limitations 1[p]-1[i]; EX1005, [0002]-[0003]; EX1006, [0002]; EX1003, ¶197.

Additionally, each of dependent claims 2-9, 23-26, and 32-33 is mapped to Yoshida-Katayama in that same context of such a nonaqueous battery, such that Yoshida-Katayama also renders obvious the separator features of claims 2-9, 23-26, and 32-33 in that same context of the nonaqueous battery of claim 10. *See* Limitations 2-9, 23-26, 32-33; EX1005, [0002]-[0003]; EX1006, [0002]; EX1003, ¶198.

Limitation 11: “The nonaqueous electrolyte battery according to claim 10, wherein a thermal shrinkage ratio of the separator is 10% or less at a

temperature T (° C.) that is 10° C. lower than the heat generation starting temperature of the positive electrode (where an upper limit of T is 200° C.).”

See Limitation 10[f] and Limitation 2; EX1003, ¶199.

Limitation 12: “The nonaqueous electrolyte battery according to claim 10, wherein a width of the separator is larger than that of the negative electrode at a temperature T (° C.) that is 10° C. lower than the heat generation starting temperature of the positive electrode (where an upper limit of T is 200° C.).”

Yoshida-Katayama renders obvious a nonaqueous electrolyte battery wherein a width of the separator is larger than that of the negative electrode at the specified temperature. EX1003, ¶¶200-02. *See* Limitation 11 (separator shrinkage of 2% or less).

Yoshida discloses exemplary dimensions for a battery in which positive and negative electrodes had dimensions of 50 mm x 200 mm, and the separator was cut to a width of 52 mm x 210 mm. EX1005, [0034]; EX1003, ¶201. It would have been obvious for the Yoshida-Katayama structure to be implemented with the dimensions disclosed by Yoshida. EX1003, ¶201.

As explained above in Sections IX.A.3-IX.A.4, heat-resistant layer 3b of the Yoshida-Katayama structure would have been made by a solvent-extraction method (EX1006, [0089], [0091]; EX1003, ¶202), which a POSITA would have expected to result in isotropic shrinkage properties that are the same in both the width and length

directions. §VII.E. Thus, applying the maximum of 2% shrinkage at 200°C to the 52 mm x 210 mm dimensions of the separator, would result in the separator having dimensions of 50.96 mm x 205.8 mm. EX1003, ¶202. A POSITA would have considered the short dimension to be the width. *Id.* However, both of these are larger than the corresponding “cold” dimension, such that this example would meet Limitation 12 regardless of which is considered the width. *Id.*

Limitation 13 “The nonaqueous electrolyte battery according to claim 10, wherein the positive active material is at least one selected from the group consisting of the following: a spinel-type lithium-containing complex oxide expressed as a general formula $\text{Li}_{1+t}\text{Mn}_{(2-x)}\text{M}^1_x\text{O}_4$ (where M^1 is at least one element selected from the group consisting of Fe, Ni, Mg, Zn, Co, Cr, Al, B, V, Si, Sn, Nb, Ta, Cu, Mo, Ti, and W, $-0.1 \leq t \leq 0.1$, and $0 \leq x \leq 0.6$); an olivine-type lithium-containing complex oxide expressed as a general formula LiM^2PO_4 (where M^2 is Co, Ni, Mn, or Fe); a lithium-containing complex oxide having a layered crystal structure expressed as a general formula $\text{Li}_{(1+a)}\text{M}^3_{2b}\text{Mn}_{(0.5-b)}\text{Ni}_{(0.5-b)}\text{O}_2$ (where M^3 is at least one element selected from the group consisting of Fe, Mg, Zn, Co, Cr, Al, B, V, Si, Sn, Nb, Ta, Cu, Mo, Ti, and W, $-0.1 < a < 0.1$, and $0 \leq b \leq 0.05$); and a lithium-containing complex oxide expressed as a general formula $\text{Li}_{(1+y+a)}\text{Ni}_{(1-y-z-\delta)/2}\text{Mn}_{(1-y-z-\delta)/2}\text{M}^4_z\text{O}_2$ (where M^4 is at least one element

selected from the group consisting of Ti, Cr, Fe, Co, Cu, Zn, Al, Ge, Sn, Mg, and Zr, $-0.1 \leq y \leq 0.1$, $-0.05 \leq \alpha \leq 0.05$, $0 \leq z < 0.45$, and $-0.24 \leq \delta \leq 0.6$).

Yoshida-Katayama renders obvious a nonaqueous electrolyte battery with one of the listed materials. EX1003, ¶203. As explained above in Sections IX.A.3-IX.A.4, Yoshida-Katayama render obvious for Yoshida's positive electrode at least the use LiFePO_4 and $\text{LiMn}_{1/3}\text{Ni}_{1/3}\text{Co}_{1/3}\text{O}_2$, both of which are included in Limitation 13. EX1006, [0106]; EX1003, ¶203. Katayama confirms that its LiFePO_4 is an "olivine-type compound." EX1006, [0106].

Limitation 14: "The nonaqueous electrolyte battery according to claim 10, wherein a content of the heat-resistant fine particles in the heat-resistant layer of the separator is 80 vol % or more of a total volume of components in the heat-resistant layer."

See Limitation 10[f] and Limitation 3; EX1003, ¶204.

Limitation 15: "The nonaqueous electrolyte battery according to claim 10, wherein the heat-resistant fine particles of the separator are inorganic fine particles."

See Limitation 10[f] and Limitation 4; EX1003, ¶205.

Limitation 16: “The nonaqueous electrolyte battery according to claim 15, wherein the inorganic fine particles include line [sic] particles of at least one selected from the group consisting of alumina, silica, BaTiO₃, boehmite, zeolite, and kaoline.”

See Limitation 10[f] and Limitation 5; EX1003, ¶206.

Limitation 17: “The nonaqueous electrolyte battery according to claim 10, wherein the heat-resistant fine particles of the separator include plate-like particles.”

See Limitation 10[f] and Limitation 6; EX1003, ¶207.

Limitation 18: “The nonaqueous electrolyte battery according to claim 10, wherein the heat-resistant layer of the separator has a thickness of 2 µm to 6 µm.”

See Limitation 10[f] and Limitation 7; EX1003, ¶208.

Limitation 19: “The nonaqueous electrolyte battery according to claim 10, wherein the thermoplastic resin of the separator includes polyolefin.”

See Limitation 10[f] and Limitation 8; EX1003, ¶209.

Limitation 20: “The nonaqueous electrolyte battery according to claim 10, wherein the shutdown layer of the separator is located on a negative electrode side.”

Yoshida-Katayama renders obvious a battery with a shutdown layer of the separator that may be located on a negative electrode side. EX1003, ¶¶210-11. A POSITA would have understood that in Yoshida’s battery cell with a positive electrode, Yoshida’s two-layer separator, and a negative electrode, there were only two options for positioning the separator layer: (1) shutdown layer 3a facing/contacting the positive electrode, and the heat-resistant layer 3b facing/contacting the negative electrode, and (2) the heat-resistant layer 3b facing/contacting the positive electrode, and the shutdown layer facing/contacting the negative electrode. EX1003, ¶210. While Yoshida depicts the first option (EX1005, FIG. 1), Yoshida does not explain any reason to prefer that configuration. EX1003, ¶210. And Katayama confirms that—in such a two-layer separator, the shutdown layer can be formed only on the negative electrode. EX1006, [0149]; EX1003, ¶210. A POSITA therefore would have understood that Yoshida’s battery could be formed with the shutdown layer 3a facing and in contact with the negative electrode—i.e., on the negative electrode side of the separator—and the heat-resistant layer 3b facing and in contact with the positive electrode, and that doing so was an obvious choice of one of two available options. EX1003, ¶210.

Additionally, a POSITA would have been motivated to position the shutdown layer on the negative side of the separator, as a POSITA would have known that a polyolefin shutdown layer could only oxidize on the positive electrode and would therefore have been motivated to avoid that risk. *Id.*, ¶211.

Limitation 21: “The nonaqueous electrolyte battery according to claim 10, wherein the shutdown layer of the separator is not in contact with the positive active material.”

Yoshida-Katayama renders obvious a battery with a shutdown layer of the separator that where is the shutdown layer is not in contact with the positive active material. EX1003, ¶212. As explained for Limitation 20, it would have been obvious for a POSITA to reverse the orientation of Yoshida’s separator layers—i.e., with the shutdown layer 3b in contact with the positive electrode, such that the shutdown layer 3a would not be in contact with the positive electrode or its positive active material 1b. *Id.*

Limitation 22: “The nonaqueous electrolyte battery according to claim 10, wherein the heat-resistant fine particles of the separator have an average particle size of 1.5 µm or less.”

See Limitation 10[f] and Limitation 9; EX1003, ¶213.

Limitation 23: “The battery separator according to claim 1, wherein the shutdown layer has a thickness of 16 μm or less.”

Yoshida-Katayama renders obvious a separator with a shutdown layer that has a thickness of 16 μm or less. EX1003, ¶214. As explained above in Sections IX.A.3-IX.A.4 and for Limitation 1[f], Yoshida-Katayama renders obvious the shutdown layer 3a having a thickness of 3-10 μm . EX1006, [0081]-[0082]; EX1003, ¶214. This “preferred” range falls entirely within the claimed range. EX1003, ¶214.

Limitation 24: “The battery separator according to claim 1, wherein a content of the binder in the heat-resistant layer is 1 to 20 vol % of a total volume of components in the heat-resistant layer.”

Yoshida-Katayama renders obvious a separator with a heat-resistant layer having 1 to 20 vol % of binder. EX1003, ¶215. As explained above for Limitation 3, Yoshida-Katayama renders obvious 80 vol. % or more of particles in the heat-resistant layer. *Id.* Because the heat-resistant layer is formed by mixing the particles with solvent and binder, and then evaporating (removing) the solvent, a particle content of 80 vol. % or more means that the binder content is necessarily 1 to 20 vol. %. *Id.*

Limitation 25: “The battery separator according to claim 1, wherein the binder includes at least one selected from the group consisting of an ethylene-vinyl acetate copolymer (having 20 to 35 mol % of a structural unit derived from vinyl acetate); an ethylene-acrylic acid copolymer; fluoro-rubber; styrene-butadiene rubber; carboxymethyl cellulose; hydroxyethyl cellulose; polyvinyl alcohol; polyvinyl butyral; polyvinyl pyrrolidone; poly-N-vinylacetamide; a cross-linked acrylic resin; polyurethane; and an epoxy resin.”

Yoshida-Katayama renders obvious a separator with the binder includes at least one of the listed options. *Id.*, ¶216. As explained above in Sections IX.A.3-IX.A.4, the heat-resistant layer 3b of the Yoshida-Katayama structure would include any of the binders Katayama discloses as preferred—EVA, ethylene-acrylic acid copolymers, fluorine-based rubber, or SBR (EX1006, [0068]-[0069]), all of which are claimed. EX1003, ¶216.

Limitation 26: “The battery separator according to claim 1, wherein the heat-resistant fine particles have an average particle size of 0.3 μm or more.”

Yoshida-Katayama renders obvious a separator wherein the heat-resistant line particles have an average particle size of 0.3 μm or more. EX1003, ¶217. As explained above in Sections IX.A.3-IX.A.4 and for Limitation 1[c], the Yoshida-Katayama structure includes a [purple] heat-resistant layer 3b (EX1005, [0021],

[0023]-[0024]) that includes the silica fine particles of Katayama's Example 1 (EX1006, [0124]). EX1003, ¶217. These particles have an "average particle diameter: 0.4 μm " (EX1006, [0123]) which is measured using the same "LA-920" analyzer used in the '251 Patent itself. *Compare id.*, [0049] with EX1001, 6:49-53.

Limitation 27: "The nonaqueous electrolyte battery according to claim 10, wherein the shutdown layer of the separator has a thickness of 16 μm or less."

See Limitation 10[f] and Limitation 23; EX1003, ¶218.

Limitation 28: "The nonaqueous electrolyte battery according to claim 10, wherein a content of the binder in the heat-resistant layer of the separator is 1 to 20 vol % of a total volume of components in the heat-resistant layer."

See Limitation 10[f] and Limitation 24; EX1003, ¶219.

Limitation 29: “The nonaqueous electrolyte battery according to claim 10, wherein the binder of the separator includes at least one selected from the group consisting of an ethylene-vinyl acetate copolymer (having 20 to 35 mol % of a structural unit derived from vinyl acetate); an ethylene-acrylic acid copolymer; fluoro-rubber; styrene-butadiene rubber; carboxymethyl cellulose; hydroxyethyl cellulose; polyvinyl alcohol; polyvinyl butyral; polyvinyl pyrrolidone; poly-N-vinylacetamide; a cross-linked acrylic resin; polyurethane; and an epoxy resin.”

See Limitation 10[f] and Limitation 25; EX1003, ¶220.

Limitation 30: “The nonaqueous electrolyte battery according to claim 10, wherein the heat-resistant fine particles of the separator have an average particle size of 0.3 μm or more.”

See Limitation 10[f] and Limitation 26; EX1003, ¶221.

Limitation 31: “The nonaqueous electrolyte battery according to claim 10, wherein the shutdown layer of the separator is not in contact with the positive active material, and a charging potential of the positive electrode is 4.3 V or more.”

Yoshida-Katayama renders obvious a battery wherein the shutdown layer of the separator is not in contact with the positive active material, and a charging potential of the positive electrode is 4.3 V or more. *Id.*, ¶222. *See* Limitation 21

(shutdown layer not in contact with positive active material). As explained in Section VII.A, a POSITA understood that current cathode materials then used in lithium ion batteries had higher theoretical capacities, and high voltage lithium ion batteries had been developed and were known to a POSITA. EX1017, [0019] (“4.3 V ... 4.6 V”); EX1003, ¶222. As such, it would have been obvious in view of a POSITA’s knowledge of higher-voltage lithium ion battery cells to implement the Yoshida-Katayama battery with a charge potential of 4.3 V or more. EX1003, ¶222.

Limitation 32: “The battery separator according to claim 1, wherein the heat-resistant layer has a porosity of 20% to 60%.”

Yoshida-Katayama renders obvious a separator with a heat-resistant layer that has a porosity of 20% to 60%. EX1003, ¶¶223-24. As explained above in Sections IX.A.3-IX.A.4, the heat-resistant layer 3b would have a porosity of 10-50% (EX1006, [0051], [0085]). EX1003, ¶223. The majority of this range—75%—overlaps the claimed range $((50-20)/(50-10) = 75\%)$. Cf. *Genentech*, 946 F.3d at 1338; *Wm. Wrigley Jr. Co.*, 683 F.3d at 1362; EX1003, ¶223.

Moreover, given Katayama’s guidance that the porosity of the overall separator is preferably 20% to 60%, with the 20% floor being necessary to secure liquid capacity for the electrolyte and improving the ionic permeability, a POSITA would have been motivated to configure the heat-resistant layer 3b to have a porosity of at least 20% to ensure that heat-resistant layer 3b would not unduly restrict the

porosity of the overall separator. EX1003, ¶224. A POSITA would have had a reasonable expectation of success because 20%-50% porosity is within (and most of) Katayama's disclosed range of porosities. *Id.*

Limitation 33: “The battery separator according to claim 1, wherein the whole separator has a porosity of 30% to 70%.”

Yoshida-Katayama renders obvious a separator with a porosity of 30% to 70%. EX1003, ¶¶225-26. As explained above in Sections IX.A.3-IX.A.4, Yoshida-Katayama renders obvious a separator with an overall porosity of 20% to 60%. EX1006, [0083]; EX1003, ¶225. The majority of this range—75%—overlaps the claimed range $((60-30)/(60-20) = 75\%)$. *Cf. Genentech*, 946 F.3d at 1338; *Wm. Wrigley Jr. Co.*, 683 F.3d at 1362; EX1003, ¶225.

Moreover, given Katayama's guidance that the porosity of the overall separator is preferably 20% to 60%, with the 20% floor being necessary to secure liquid capacity for the electrolyte and improving the ionic permeability, a POSITA would have been motivated to configure the heat-resistant layer 3b to have a porosity of at least 20% to ensure that heat-resistant layer 3b would not unduly restrict the porosity of the overall separator. EX1003, ¶226. A POSITA would have had a reasonable expectation of success because 20%-50% porosity is within (and most of) Katayama's disclosed range of porosities. *Id.*

Limitation 34: “The nonaqueous electrolyte battery according to claim 10, wherein the heat-resistant layer has a porosity of 20% to 60%.”

See Limitation 10[f] and Limitation 32; EX1003, ¶227.

Limitation 35: “The nonaqueous electrolyte battery according to claim 10, wherein the whole separator has a porosity of 30% to 70%.”

See Limitation 10[f] and Limitation 33; EX1003, ¶228.

Limitation 36: “The battery separator according to claim 1, wherein the microporous film is formed by a solvent extraction method, a dry drawing method, or a wet drawing method.”

Yoshida-Katayama renders obvious a separator wherein the microporous film is formed by a solvent extraction method. EX1003, ¶¶182-184. As explained above in Sections IX.A.3-IX.A.4, shutdown layer 3a of the Yoshida-Katayama structure would have been made by a solvent-extraction method. EX1006, [0089], [0091]; EX1003, ¶229.

Limitation 37: “The nonaqueous electrolyte battery according to claim 10, wherein the microporous film is formed by a solvent extraction method, a dry drawing method, or a wet drawing method.”

See Limitation 10[f] and Limitation 36; EX1003, ¶230.

X. CONCLUSION

For these reasons, claims 1-37 are invalid.

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Respectfully submitted,

/Eagle H. Robinson/

Eagle H. Robinson

Reg. No. 61,361

Lead Counsel for Petitioner

CERTIFICATE OF WORD COUNT

Pursuant to 37 C.F.R. § 42.24(a)(i), the undersigned certifies that this Paper—exclusive of the table of contents, mandatory notices under § 42.8, certificate of service, and this certificate of word count—includes 13,956 words.

/Eagle H. Robinson/
Eagle H. Robinson (Reg. No. 61,361)

CERTIFICATE OF SERVICE

Pursuant to 37 C.F.R. § 42.6(e) and 37 C.F.R. § 42.105(a), the undersigned certifies that on December 14, 2022, a complete copy of this Petition for *Inter Partes* Review, Petitioner's power of attorney, and all exhibits were served on Patent Owner at the correspondence addresses of record listed below by FedEx®:

BIRCH STEWART KOLASCH & BIRCH, LLP
8110 Gatehouse Road
Suite 100 East
Falls Church VA 22042-1248

Petitioner also certifies that a courtesy copy of this Petition was sent via email to Patent Owner's litigation counsel:

Abigail Lubow (alubow@velaw.com)
Eric Klein (eklein@velaw.com)
Erik Shallman (eshallman@velaw.com)
Hilary Preston (hpreston@velaw.com)
Jeffrey Han (jhan@velaw.com)

/Eagle H. Robinson/
Eagle H. Robinson (Reg. No. 61,361)