

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

ZHUHAI COSMX BATTERY CO., LTD.,
Petitioner

v.

NINGDE AMPEREX TECHNOLOGY LIMITED,
Patent Owner

Case IPR2026-00401
U.S. Patent No. 12,294,082

DECLARATION OF SAMUEL P. GIDO, PH.D.

TABLE OF CONTENTS

I.	INTRODUCTION	1
II.	BACKGROUND AND QUALIFICATIONS	1
III.	MATERIALS CONSIDERED	9
IV.	RELEVANT LEGAL STANDARDS	11
	A. Level of Ordinary Skill in the Art	12
	B. Anticipation	13
	C. Obviousness	13
	D. Claim Construction	16
V.	TECHNOLOGY BACKGROUND	16
	A. Lithium-Ion Battery Technology	16
	B. Anode Technology	18
VI.	THE '082 PATENT	20
	A. Specification and Claims	20
	B. Prosecution History	22
	1. The '129 Application	22
	2. Prior Art Never Considered by Examiner	25
VII.	SUMMARY OF GROUNDS OF INVALIDITY	27
VIII.	GROUND 1: MANABE RENDERS OBVIOUS CLAIMS 1-4, 7-12	28
	A. Overview of Manabe	28
	B. Independent Claim 1	34
	1. [1.pre]: “A negative electrode, comprising:”	34

2.	[1.1]: “a negative current collector”	35
3.	[1.2]: “a first negative active material layer, wherein the first negative active material layer is arranged on one side of a first portion of the negative current collector; and”	36
4.	[1.3]: “a second negative active material layer, wherein the second negative active material layer is arranged on two sides of a second portion of the negative current collector, wherein the second portion of the negative current collector is different from the first portion of the negative current collector;”	37
5.	[1.4]: “wherein a ratio of a weight per unit area of the first negative active material layer to a weight per unit area of the second negative active material layer on the negative current collector is 0.47 to 0.52, and”	38
6.	[1.5]: “a ratio of a compacted density of the first negative active material layer to a compacted density of the second negative active material layer is 0.9 to 1.1;”	41
7.	[1.6]: “wherein a thickness of the first negative active material layer is 40 μm to 60 μm , and a thickness of the second negative active material layer on each of the two sides of the second portion is 40 μm to 60 μm .”	43
C.	Dependent Claim 2	44
1.	[2.1]: “The negative electrode according to claim 1, the weight per unit area of the first negative active material layer on the first portion is 65 g/m^2 to 130 g/m^2 , and the weight per unit area of the second negative active material layer on the second portion is 130 g/m^2 to 260 g/m^2 .”	44
D.	Dependent Claim 3	45
1.	[3.1]: “The negative electrode according to claim 1, wherein the first negative active material layer and the second negative active material layer each independently comprise a silicon-based material and graphite, wherein	

	the silicon-based material is selected from the group consisting of silicon oxide, silicon carbon, and a combination thereof.”	45
E.	Dependent Claim 4	47
1.	[4.1]: “The negative electrode according to claim 3, wherein a weight of the silicon-based material in the first negative active material layer and the second negative active material layer is greater than or equal to 5% and less than 100%, based on a total weight of the silicon-based material and the graphite.”	47
F.	Dependent Claim 7	48
1.	[7.1]: “The negative electrode according to claim 3, wherein the silicon-based material further comprises a carbon coating layer.”	48
G.	Dependent Claim 8	48
1.	[8.1]: “The negative electrode according to claim 3, wherein the first negative active material layer and the second negative active material layer each independently comprise a binder and a conductive agent;”	48
2.	[8.2]: “wherein the binder comprises a material selected from the group consisting of polyacrylate, polyimide, polyamide, polyamideimide, polyvinylidene fluoride, styrene-butadiene rubber, sodium alginate, polyvinyl alcohol, polytetrafluoroethylene, polyacrylonitrile, sodium carboxymethyl cellulose, potassium carboxymethyl cellulose, and a combination thereof; and”	49
3.	[8.3]: “the conductive agent comprises a material selected from the group consisting of conductive carbon black, acetylene black, Ketjen black, graphene, and a combination thereof.”	50
H.	Dependent Claim 9	51

1.	[9.1]: “The negative electrode according to claim 8, wherein based on a total weight of the first negative active material layer, the total weight of the silicon-based material and the graphite in the first negative active material layer is 94% to 96%, a weight of the binder is 2.8% to 5.0%, and a weight of the conductive agent is 0.4% to 1.6%; and based on a total weight of the second negative active material layer, the total weight of the silicon-based material and the graphite in the second negative active material layer is 94% to 96%, the weight of the binder is 2.8% to 4.0%, and the weight of the conductive agent is 0.4% to 1.6%.”	51
I.	Independent Claim 10	59
1.	[10.pre]: “An electrochemical apparatus, comprising:”	59
2.	[10.1]: “a positive electrode;”	60
3.	[10.2]: “a separator; and”	61
4.	[10.3]: “a negative electrode; wherein the negative electrode comprises”	62
5.	[10.4]: “a negative current collector;”	63
6.	[10.5]: “a first negative active material layer, wherein the first negative active material layer is arranged on one side of a first portion of the negative current collector;”	63
7.	[10.6]: “and a second negative active material layer, wherein the second negative active material layers are arranged on two sides of a second portion of the negative current collector, wherein the second portion of the negative current collector is different from the first portion of the negative current collector,”	63
8.	[10.7]: “wherein a ratio of a weight per unit area of the first negative active material layer to a weight per unit area of the second negative active material layer on the negative current collector is 0.47 to 0.52,”	63

9.	[10.8]: “and a ratio of a compacted density of the first negative active material layer to a compacted density of the second negative active material layer is 0.9 to 1.1;”	64
10.	[10.9]: “wherein a thickness of the first negative active material layer is 40 μm to 60 μm , and a thickness of the second negative active material layer on each of the two sides of the second portion is 40 μm to 60 μm .”	64
J.	Dependent Claim 11	64
1.	[11.1]: “An electronic apparatus, comprising the electrochemical apparatus according to claim 10.”	64
K.	Dependent Claim 12	65
1.	[12.1]: “The electrochemical apparatus according to claim 10, the weight per unit area of the first negative active material layer on the first portion is 65 g/m ² to 130 g/m ² , and the weight per unit area of the second negative active material layer on the second portion is 130 g/m ² to 260 g/m ² .”	65
IX.	GROUND 2: MANABE AND INABA RENDER OBVIOUS CLAIMS 5 AND 6	65
A.	Overview of Inaba	65
B.	Dependent Claim 5	71
1.	[5.1]: “The negative electrode according to claim 3, wherein a form of the silicon-based material comprises a crystalline state, an amorphous state, or a combination thereof,”	71
2.	[5.2]: “wherein the first negative active material layer has a particle size Dv50 of 8.0 μm to 20 μm , and the second negative active material layer has a particle size Dv50 of 8.0 μm to 20 μm .”	78
C.	Dependent Claim 6	84

1.	[6.1]: “The negative electrode according to claim 3, wherein for the silicon-based material, a ratio of a peak height at a wavenumber of $500\text{ cm}^{-1}\pm 10\text{ cm}^{-1}$ to a peak height at a wavenumber of $1350\text{ cm}^{-1}\pm 10\text{ cm}^{-1}$ in a Raman spectrum is greater than 0.”	84
X.	GROUND 3: MANABE AND WANG RENDER OBVIOUS CLAIM 5	89
A.	Overview of Wang	89
B.	Dependent Claim 5	92
1.	[5.1]: “The negative electrode according to claim 3, wherein a form of the silicon-based material comprises a crystalline state, an amorphous state, or a combination thereof,”	92
2.	[5.2]: “wherein the first negative active material layer has a particle size $Dv50$ of $8.0\text{ }\mu\text{m}$ to $20\text{ }\mu\text{m}$, and the second negative active material layer has a particle size $Dv50$ of $8.0\text{ }\mu\text{m}$ to $20\text{ }\mu\text{m}$.”	92
XI.	CONCLUSION.....	101

I. INTRODUCTION

1. I have been retained by Lee & Hayes, P.C. as a technical expert for Zhuhai CosMX Battery Co., Ltd. (“CosMX” or “Petitioner”), who is the Petitioner in an *Inter Partes* review before the United States Patent and Trademark Office involving U.S. Patent No. 12,294,082 (“the ’082 Patent,” EX1001).

2. Specifically, I have been retained as an independent expert consultant by Petitioner to provide my opinions on the technology claimed in, and the patentability of claims 1-19 (“the challenged claims”) of the ’082 Patent. Although I am being compensated at my usual rate of \$650 per hour for the time I spend on this matter, no part of my compensation depends on the outcome of this proceeding, and I have no financial interest in any of the parties. I have no affiliation with either party in this case besides having been retained as an independent consultant in this matter.

3. I have personal knowledge of the facts and matters in this declaration and believe them to be true.

II. BACKGROUND AND QUALIFICATIONS

4. As my CV shows, I am a professor of polymer science and engineering with experience in polymer chemistry and structure as applied to applications, including lithium ion batteries, fuel cells, and composites.

5. I have been on the faculty at the University of Massachusetts at Amherst since 1993. I am currently Associate Professor of Polymer Science and

Engineering. I have broad expertise across the fields of polymers (plastics), polymer-nanoparticle composites, fluorinated polymers, polyolefins, porous materials, phase separations, and coating processes. I am an expert in and experienced user of a range of materials characterization techniques including scattering, diffraction and spectroscopies including FTIR and Raman, as well as electron microscopy. Over the years I have studied materials for a broad range of applications, including batteries, fuel cells, adhesives, non-stick coatings, elastomers, composites, and nanostructures. In addition to academic research, I have done research for and/or consulted for a range of companies including W.L. Gore, Boston Scientific, FujiFilm (Japan), Kureha Chemical Industry (Japan), Sekisui Chemical Co. (Japan), Loctite Corp. (now Henkel), Rexam Graphics, St. Gobain, and Scapa Tape.

6. I studied for my Bachelor of Science in Chemical Engineering at Princeton University and graduated Magna Cum Laude in 1988. While at Princeton, I did research at the nearby Textile Research Institute (“TRI”), where I focused on applying coatings to porous substrates. After graduating from Princeton in 1988, I entered a doctoral program at the Massachusetts Institute of Technology (“MIT”). My home department at MIT was Chemical Engineering, but I was also part of the interdisciplinary Program in Polymer Science and Technology (“PPST”). I did my research and doctoral thesis under Prof. Edwin L. Thomas in the Materials Science

and Engineering Department. Prof. Thomas is a world-renowned expert in polymer structure and morphology.

7. After receiving my Ph.D. in 1993, I began my career as an Assistant Professor in the Polymer Science and Engineering Department at the University of Massachusetts at Amherst. Over my academic career my work has been supported by millions of dollars in research funding from government agencies (U.S. Army, National Science Foundation, U.S. Department of Education), foundations (Bill and Melinda Gates Foundation, W. M. Keck Foundation), and industry.

8. I have focused on a bottom-up concept of new materials design for advanced applications. In particular, I have worked on developing new molecular structures to control nanometer- and micrometer-scale structure and morphology, aimed at improving mechanical strength, transport (diffusion) of gases, liquids, and ions in porous materials, electrical properties, and adhesion. A large part of this research is on controlling phase separation behavior (coagulation) to form unique, functional structures.

9. I have numerous publications including 14 issued patents, including patents on fluoropolymers and their applications, including for batteries, fuel cell separators, and novel audio devices. I have conducted research on materials for batteries and fuel cells, including fluorinated polymers and polymer-particle composites, with funding from Kureha (Japan) and the U.S. Army. Myself and one

of my graduate students also worked on a battery research project, at the University of Massachusetts sponsored by Sekisui Chemical (Japan), in which we experimented with new materials, formulations and structures, for separators and electrode binders. This project involved building and testing lithium-ion battery cells. These studies involved developing polymer chemistries, nano- and micro-scale composite structures and porous structures, and coating processes to enhance ion conductivity.

10. I have worked, and continue to work, as a consultant for W.L. Gore, a leading company in fluorinated polymers. I have consulted for industry on coating processes, particularly for Rexam Graphics and Scapa Tape. I was also a co-founder of Smart Surfaces LLC, a startup that developed environmentally friendly, non-stick marine coatings to prevent biological fouling. Smart Surfaces was sold to FujiFilm in 2006, and I continued consulting for FujiFilm Smart Surfaces LLC. These silicone-based coatings contained silicon oxide filler particles.

11. I conducted a research project for Loctite Corporation using electron microscopy to study adhesive polymer layers filled with inorganic reinforcing particles. I also performed research for Boston Scientific—which resulted in a U.S. patent—on polymer coatings for heart stents, and I characterized them with electron microscopy. In this work for Boston Scientific, I studied the diffusion of a drug through this porous coating layer.

12. I have done substantial work on composites of polymers and inorganic nanoparticles, and specifically on silicon and silicon oxide particles incorporated into composites with carbon-based materials and polymers. These studies have been published in peer reviewed journals and have been the subject of talks at national technical conferences:

LeiZheng, Sheng Hong, Gregoire Cardoen, Engin Burgaz, Samuel P. Gido, and E. Bryan Coughlin. "Polymer Nanocomposites through Controlled Self-Assembly of Cubic Silsesquioxane Scaffolds" *Macromolecules* 2004, 37, 8606-8611.

Lin, Ying; Daga, Vikram; Anderson, Eric; Gido, Samuel; Watkins, James "Nanoparticle-Driven Assembly of Block Copolymers: A Simple Route to Ordered Hybrid Materials" *J. Am. Chem. Soc'y.* **131**, 6513-6516, 2011

Daga, Vikram K.; Anderson, Eric R.; Gido, Samuel P.; Watkins, James J. "Hydrogen Bond Assisted Assembly of Well-Ordered Polyhedral Oligomeric Silsesquioxane-Block Copolymer Composites" *Macromolecules* **44**, 6793-6799, 2011.

Williams, Katherine Grace; Gido Samuel Patrick; Coughlin Edward Bryan. "Polymers and Copolymers Containing Covalently Bonded Polyhedral Oligomeric Silsesquioxanes Moieties" *Applications of Polyhedral Oligomeric*

Silsesquioxanes. Editor: Thompson C. Hartmann. Book Series:
Advances in Silicon Science. Vol.: 3. Pages: 167-207. 2011.

Cardoen, G.; Mays, J.W.; Gido, S.P.; Russell, T.P.; Hu, X.C.;
Baskaran, D.; Coughlin, E.B. "POSS containing multiblock
copolymers as model of well-defined organic-inorganic hybrid
materials" Abstracts of Papers of the Am. Chem. Soc'y. 230:
U4013-U4014 31-POLY AUG 28 2005.

13. I have experience using Raman spectroscopy in my research and I have
published Raman data in peer reviewed journals:

Robin L. McKiernan, Amy M. Heintz, Shaw L. Hsu, Edward
D. T. Atkins, Jacques Penelle and Samuel P. Gido, "Influence
of Hydrogen-Bonding on the Crystallization Behavior of Semi-
Crystalline Polyurethanes," *Macromolecules*, **2002**, 35, 6970-
6974.

R. L. McKiernan, Gregoire Cardoen, Bernard Boutevin, Bruno
Ameduri, Samuel P. Gido, and Jacques Penelle,
"Macromolecular Crystal Engineering Based on Segmented
Polymers: Influence of Heteroatoms on the Thermal Properties
and Crystallization of *m,n*-Polyurethanes Derived from Long-
Chain, Heteroatom-Containing, Monodisperse α,ω -Diols,"
Macromolecular Chemistry and Physics, 2003, 204(7), 961-
969.

14. Styrene butadiene rubber (SBR) is a copolymer of styrene and butadiene which is taught and claimed in the '082 Patent as a binder for negative electrodes. SBR is used as a binder in the prior art that I examined. I have extensive experience working with styrene butadiene copolymers and applying them as elastomers (i.e., rubber). My work on styrene butadiene copolymers is the subject of peer reviewed publications and two issued patents.

Yuqing Zhu, Roland Weidisch, Samuel P. Gido, Gabriel Velis and Nikos Hadjichristidis, "Morphologies and Mechanical Properties of a Series of Block-Double-Graft Copolymers and Terpolymers," *Macromolecules* **2002**, 35, 5903-5909.

Y. Zhu, S. P. Gido, H. Iatrou, N. Hadjichristidis, and J. Mays, "Microphase-Separation of Cyclic Block Copolymers of Styrene and Butadiene and of Their Corresponding Linear Triblock Copolymers," *Macromolecules* **2003**, 36, 148-152.

J. W. Mays, S. P. Gido, R. Weidisch. "Multigraft Copolymers as Superelastomers." **United States Patent** 9,708,434. Granted July 18, 2017.

J. W. Mays, S. P. Gido, R. Weidisch. "Multigraft Copolymers as Superelastomers." **European Patent** EP2622015B1. December 16, 2015.

15. One of the best ways to deeply understand a topic is to teach it. I have taught, and continue to teach, subjects relevant to this matter to advanced graduate

students (doctoral candidates) in the Polymer Science and Engineering Department at the University of Massachusetts at Amherst. In past years, I have taught PSE 608 Introduction to Polymer Engineering, which includes topics such as mechanical properties, coating processes, and ion diffusion of ions in materials. I have also taught PSE 602 Polymer Characterization Laboratory, in which the students gain practical laboratory experience with techniques of importance in this matter including SEM, and static laser light scattering (aka laser diffraction) for size determination.

16. I also teach PSE 608 Physical Chemistry of Polymers I and PSE 789 Physical Chemistry of Polymers II. In this sequence, I cover phase behavior, phase separations (coagulation), and the theory of laser light scattering. I also teach PSE 721 Polymer Morphology, which focuses on nano- and micro-scale structure in polymers and composites, as well as the use of electron microscopy to study material structure.

17. In addition, I teach a freshman seminar, FFYS 191POLY The Polymer Age, which examines the societal impact of polymers. As part of this class, I teach about batteries, with a particular focus on the materials used in their construction.

18. Since 1993, I have served on the faculty at the University of Massachusetts at Amherst as Associate Professor of Polymer Science and Engineering, where I have developed broad expertise in polymers, polymer-

nanoparticle composites, fluorinated polymers, porous materials, phase separations, and coating processes. My publications on fluorinated polymers and my research on these materials for separators and electrodes in batteries and fuel cells directly relate to the '082 Patent's claimed subject matter. Fluoropolymers, are key binder materials in the '082 Patent's electrode composition. I have also conducted research on materials for batteries with funding from industry and the U.S. Army, developing polymer chemistries, nano- and micro-scale composite structures and porous structures, and coating processes to enhance ion conductivity. Additionally, I regularly teach advanced graduate courses covering particle-size determination using laser light scattering (laser diffraction), the physical chemistry of polymers including phase separations, and polymer morphology focusing on nano- and micro-scale structure—all of which are central to understanding the electrode designs and particle sizes claimed in the '082 Patent.

III. MATERIALS CONSIDERED

19. In forming my opinions expressed in this declaration, I have considered, among other things, the following documents. I confirm that to the best of my knowledge the accompanying exhibits are true and accurate copies of what they purport to be, and that an expert in the field would reasonably rely on them to formulate opinions such as those set forth in this Declaration. I understand the documents have been given the following exhibit numbers in this proceeding:

Exhibit No.	Description
1001	U.S. Patent No. 12,294,082 (“the ’082 Patent”)
1002	File history of U.S. Patent No. 12,294,082
1005	U.S. Patent Application Publication No. 2018/0248220 A1 to Noriko Manabe et al. (“Manabe”)
1006	Japanese Patent Publication No. JP 2014-89855 to Inaba et al. (“Inaba”)
1007	Certified Translation of Japanese Patent Publication No. JP 2014-89855 to Inaba et al. (“Inaba”)
1008	Chinese Patent Application CN 109509909 A to Wang et al. (“Wang,” EX1008)
1009	Certified Translation of Chinese Patent Application CN 109509909 A to Wang et al. (“Wang,” EX1009)
1010	U.S. Patent Application Publication No. 2018/0316001 A1 to Kim et al. (“Kim”)
1011	U.S. Patent Application Publication No. 2014/0227562 A1 to Kamizori et al. (“Kamizori”)
1012	U.S. Patent Application Publication No. 2019/0148762 A1 to Torita et al. (“Torita”)
1013	U.S. Patent Application Publication No. 2017/0033355 A1 to Kondo et al. (“Kondo”)
1014	Manuella Cerbelaud et al., <i>Numerical and Experimental Study of Suspensions Containing Carbon Blacks Used as Conductive Additives in Composite Electrodes for Lithium Batteries</i> . LANGMUIR, Feb. 24, 2014, at 2660–2669.
1015	Sigma-Aldrich Super P product details, downloaded on June 22, 2026, from https://www.sigmaaldrich.com/US/en/product/aldrich/940259

Exhibit No.	Description
1016	S. Lim et al., <i>The effect of binders on the rheological properties and the microstructure formation of lithium-ion battery anode slurries</i> . JOURNAL OF POWER SOURCES, Sept. 11, 2015, at 221-230.
1017	Jieun Park et al., <i>How the interaction between styrene-butadiene-rubber (SBR) binder and a secondary fluid affects the rheology, microstructure and adhesive properties of capillary-suspension-type graphic slurries used for Li-ion battery anodes</i> . COLLOIDS AND SURFACES A, July 19, 2019, at 579.

20. In forming my opinions, I have also relied on my education and experience.

IV. RELEVANT LEGAL STANDARDS

21. I am not an attorney. My analysis and opinions are based on my background and expertise in this technical field, as well as the instructions I have been given by counsel for the legal standards relating to patentability.

22. I have been informed by counsel for Petitioner that the following legal principles may apply to analysis of patentability based on 35 U.S.C. §§ 102 for anticipation and 103 for obviousness. I have also been informed that, in an *inter partes* review proceeding such as this one, a patent claim is unpatentable if it is shown by a preponderance of the evidence that the claim would have been anticipated by a prior art patent or publication, or obvious by one or more properly combined prior art patents or publications.

A. Level of Ordinary Skill in the Art

23. I have been instructed to consider patentability of the Challenged Claims through the lens of a person of ordinary skill in the art (“POSITA”) at the time of the claimed priority date of the ’082 Patent—December 11, 2019. I am familiar with the level of ordinary skill in the subject matter of the ’082 Patent in 2019.

24. Based on my review of the technology, and drawing on my own experience in the field, my analysis below assumes that a POSITA would have had at least a bachelor’s degree in chemistry, chemical engineering, materials science, or a related field covering relevant principles of organic and inorganic chemistry, polymer processing, ceramic materials, and ceramic processing, and three or more years of experience related to electrochemical energy storage devices, lithium-ion battery technology, separators, characterizations and analyses of particle size, film thickness, and/or materials compositions, battery performance characterization, or other similar applications of polymer chemistry, ceramic chemistry, and ceramic processing. This level of skill is approximate, and more experience would compensate for less formal education, and vice versa. It is consistent with the field provided by the ’082 Patent: “the technical field of energy storage, and in particular, to a negative electrode and an electrochemical apparatus containing the same.” EX1001, 1:17-19.

25. Based on my qualifications discussed above, I qualified at least as a POSITA of the '082 Patent by 2004.

26. My analysis below considers how a POSITA would have understood the references listed above with respect to the challenged claims of the '082 Patent.

B. Anticipation

27. I have been informed a patent claim is unpatentable as anticipated under 35 U.S.C. § 102 if every limitation of the claimed invention is found in a single prior art reference--either expressly or required through inherency--as arranged in the claim.

C. Obviousness

28. I have been informed that, even if a single prior art reference does not disclose each and every element of a patent claim, the patent claim is still unpatentable as obvious under 35 U.S.C. § 103. It is my understanding that a claimed invention is unpatentable as obvious over a combination of prior art references if the differences between the claimed invention and the prior art are such that a POSITA would have found the subject matter as a whole obvious.

29. I understand that obviousness is determined by evaluating: (1) the scope and content of the prior art, (2) the differences between the prior art and the claim, (3) the level of ordinary skill in the art, and (4) any secondary considerations of non-obviousness. To establish obviousness based on a combination of the elements

disclosed in the prior art, it is my understanding that a challenger must provide a clear articulation of the reason(s) why the claimed invention would have been obvious. I understand this articulation may, but does not necessarily, require record evidence of an explicit teaching, suggestion, or motivation to combine the prior art in the way recited in a patent claim. Rather, prior art may be combined based on an express teaching, suggestion, or motivation from the prior art itself, or from a reasoned explanation of an expert witness or some other rationale.

30. For example, it is my understanding that this articulation can come from a number of rationales, which include but are not limited to (1) combining prior art elements according to known methods to yield predictable results; (2) simple substitution of one known element for another to obtain predictable results; (3) use of known technique to improve similar devices, methods, or products in the same way; (4) applying a known technique to a known device, method, or product ready for improvement to yield predictable results; (5) choosing from a finite number of identified, predictable solutions, with a reasonable expectation of success, e.g., the combination is “obvious to try”; (6) known work in one field of endeavor may prompt variations of it for use in either the same field or a different one based on design incentives or other market forces if the variations are predictable to one of ordinary skill in the art; and (7) some teaching, suggestion, or motivation in the prior

art that would have led one of ordinary skill to modify the prior art reference or to combine prior art reference teachings to arrive at the claimed limitation.

31. I further understand that these rationales may be found explicitly or implicitly: (1) in the prior art; (2) in the knowledge of those of ordinary skill in the art that certain references, or disclosures in those references, are of special interest or importance in the field; and/or (3) from the nature of the problem to be solved.

32. Additionally, I understand that the legal determination of the motivation to combine references allows recourse to logic, judgment, and common sense. In order to resist the temptation to read into prior art the teachings of the invention in issue, however, it should be apparent that the expert is not conflating “common sense” and what appears obvious in hindsight. I understand that if the teachings of a prior art would lead a POSITA to make a modification that would render another prior art device inoperable, then such a modification may not be obvious. I also understand that if a proposed modification would render the prior art invention being modified unsatisfactory for its intended purpose, then there may be no suggestion or motivation to make the proposed modification.

33. I understand that where the prior art discloses a range overlapping the claimed range, that the claimed range is presumptively obvious.

D. Claim Construction

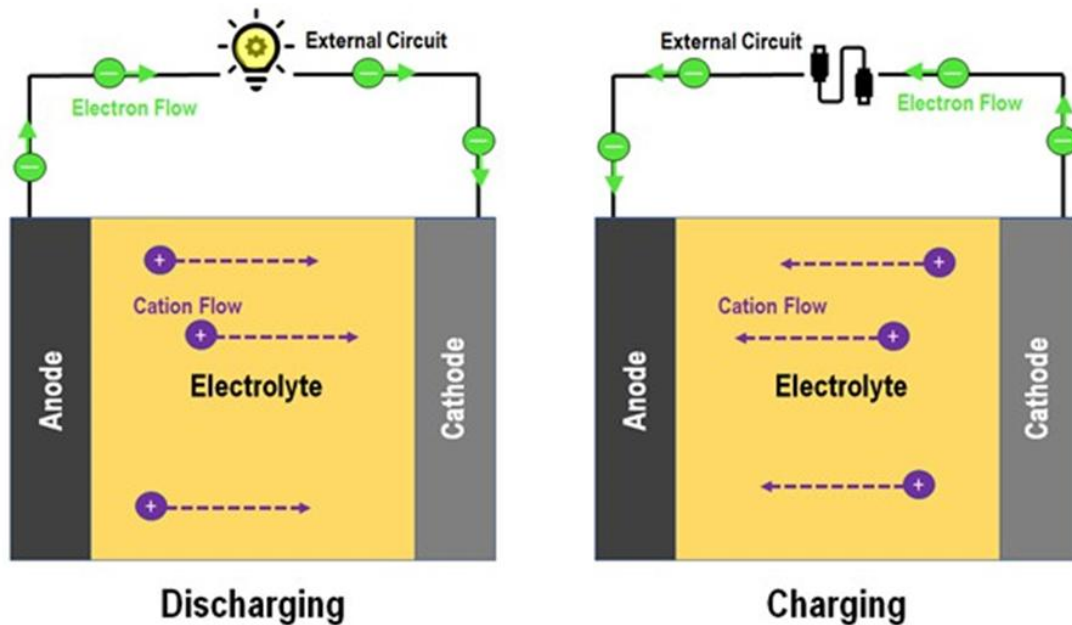
34. Counsel has instructed me that, in this proceeding, the words of a claim are to be given their plain and ordinary meaning, which the meaning understood by a person of ordinary skill in the art after reading the entire patent. This analysis focuses on how the patentee used the claim term in the claims, specification, and prosecution history. Dictionaries or extrinsic sources may assist in determining the plain and ordinary meaning, but extrinsic evidence cannot override a meaning that is unambiguous from the intrinsic evidence. I have applied the plain and ordinary meaning in my analysis below.

V. TECHNOLOGY BACKGROUND

A. Lithium-Ion Battery Technology

35. The basic structure of a battery is illustrated below:

General Battery Schematic



Battery Structure

36. As illustrated, the battery includes a negative electrode, called an anode, and a positive electrode, called a cathode. The electrodes are separated from one another and immersed in an electrolyte through which ions can be transported.

37. When the battery discharges, positive ions diffuse from the anode, through the electrolyte, to the cathode. Electrons move separately through an external circuit from the anode to the cathode, combining with the ions at the cathode. The electrons generate an electrical current when moving through the external circuit.

38. Charging the battery involves the reverse process. An external voltage pushes electrons through the external circuit to the anode, creating positive ions at

the cathode. The positive ions migrate through the electrolyte and combine with the electrons at the anode.

39. One type of battery is a lithium-ion battery. In lithium-ion batteries, the ions moving between the anode and cathode are lithium ions.

B. Anode Technology

40. As explained above, the anode of a lithium-ion battery is the component that releases lithium ions during discharge. This causes electrons to flow out of the anode into the device powered by the battery. A typical anode is comprised of a current collector coated with active material(s). The current collector provides an electrical pathway between the active material and the external circuit (i.e., device powered by the battery), while the active material stores and releases lithium ions during charging and discharging. Current collectors are typically metal foil, such as copper. Anode active materials commonly include graphite and/or silicon-based materials (e.g., silicon and silicon oxides).

41. The typical process for manufacturing an anode broadly comprises coating the active material—often in a slurry or mixture with other materials,

including binding agents¹ and conductive agents²—on the current collector at a specified weight per unit area referred to as the coating weight. The anode is then calendared through a rolling press which compacts the active material and bonds the active material to the current collector. Compaction of the active material improves volumetric energy density and electrical conductivity.

42. Finally, it was well known in the art to leave a portion of the current collector uncoated by active material. This allows the uncoated portion of the current collector to be welded or bonded to the terminal of the battery—typically through a tab—forming an electrical connection allowing the flow of electrons into and out of the anode. It is further well known that only one side of one portion of the current

¹ Common binding agents include “fluororesins such as polytetrafluoroethylene (PTFE), polyvinylidene fluoride (PVDF) and vinylidene fluoride (VDF)-hexafluoropropylene (HFP) copolymer; polyolefin resins such as polyethylene and polypropylene; polyamide resins such as aramid;” cellulose binders such as CMC, “and rubbery materials such as styrene-butadiene rubber and acrylic rubber.” EX1005, ¶[0044].

² Common conductive agents include carbon blacks such as acetylene black; conductive fibers such as carbon nanotubes and other forms of conductive carbon. EX1005, ¶[0042].

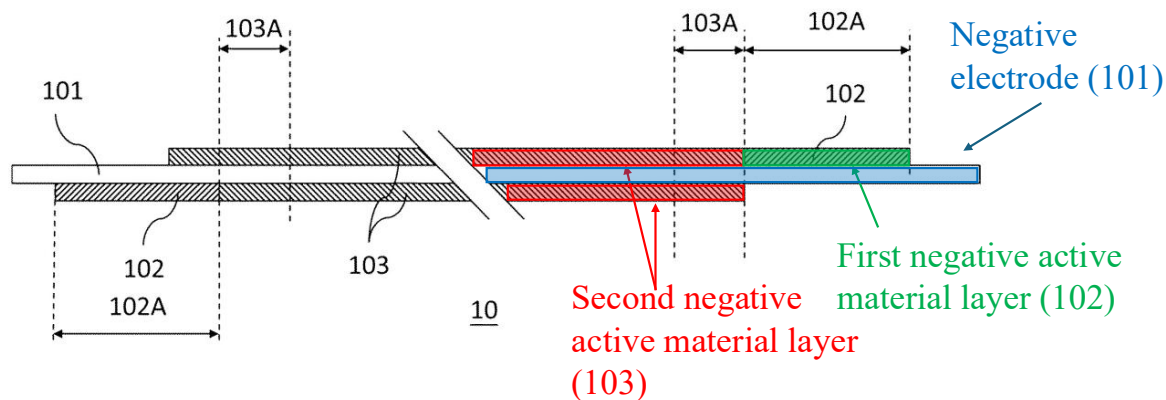
collector needs to be left uncoated, and that it is preferable to coat the rest of the current collector with active material on both sides so as to maximize the amount of active material and therefore the capacity of the battery.

VI. THE '082 PATENT

43. The '082 Patent issued on May 6, 2025, from U.S. Patent Application No. 17/707,129 (“the '129 Application”) filed March 29, 2022. This is a continuation of PCT/CN2019/130465 filed December 31, 2019. EX1001, 1. The '082 Patent claims priority to China Patent Application No. 201911267132.X filed December 11, 2019.

A. Specification and Claims

44. The '082 Patent describes a negative electrode comprising a negative current collector, a first NAML on one side of a first portion of the current collector, and a second NAML on both sides of a second portion of the current collector. EX1001, Abstract, 4:9-16. The first portion and the second portion of the current collector are separate from each other. *Id.*, Abstract, 4:16-17.



EX1001, Fig. 1*³

45. The weight per unit area (i.e., coating weight) of the first NAML and the second NAML—including the active material on both sides of the current collector—is such that the ratio of first to second NAML coating weights is 0.47-0.52. *Id.*, Abstract, 4:17-21. The ratio of compaction densities of the first to second NAMLs is 0.9-1.1. *Id.*, Abstract, 4:21-24. And the thickness of both the first and second NAMLs—for each side individually of the second NAML—is 40-60 μ m. *Id.*, Abstract, 5:55-58. In practice, the conditions mean that the first NAML is, to within fairly narrow tolerances, the same as a single layer of the second NAML in terms of coating weight and density. In a coating process to form these layer structures, a POSA would understand that the most likely method to form the first NAML is by

³ I use an asterisk “*” to indicate annotated or otherwise modified figures from the references.

continuation of the same coating process that forms the adjacent portion of the second NAML on the same side of the current collector. In this case, the first NAML and the second NAML on the same side of the current collector are different portions of the same continuously applied coating.

46. According to the '082 Patent, when negative active material layers obey the above restrictions—specifically, the restrictions on relative compaction densities and coating weights—the issues of polarization and lithium plating are alleviated. EX1001, 3:66-4:5. As a result, “cycle performance and the safety of the lithium-ion battery are improved.” *Id.*, 4:5-6; 15:10-17.

47. The independent claims recite the above negative electrode having the above-described NAML characteristics. EX1001, claims 1, 10. The '082 Patent also discloses and claims other parameters, such as specific materials in the NAMLs and their characteristics. *Id.*, claims 3-9, 11-12, 5:23-8:44.

B. Prosecution History

1. The '129 Application

48. The Examiner issued the '082 Patent despite disclosure of the claimed elements in the prior art, solely due to purported unexpected results of the combination of ratio of coating weights and ratio of compaction densities. Had the Examiner been aware of the prior art discussed in my declaration, which discloses

coating weight ratios and compaction density ratios squarely within the claimed ranges, it is my opinion that the '082 Patent would not have issued.

49. The '129 Application was initially rejected in its entirety based on Morimoto alone and in combination with other references. EX1002, 362-371; *see also*, 334-359. The Examiner found that Morimoto discloses a negative electrode comprising a negative current collector with a first NAML on one side of a first portion of the current collector and a second NAML on two sides of a second, different portion of the current collector. *Id.*, 363. The Examiner found Morimoto's first and second NAMLs are made of the same material, therefore the coating weights are proportional to the thickness of the layers. *Id.* With thicknesses of 67 μ m and 133 μ m, the corresponding ratio of coating weights is 0.503. *Id.* Because the first NAML is both 0.503 times the thickness and 0.503 times the coating weight of the second NAML, the compaction density ratio is 1. *Id.*

50. The Examiner further found that Torita (EX1012) discloses the use of silicon oxide and graphite as negative electrode active materials and that it would have been obvious to combine with Morimoto. EX1002, 364. The Examiner further found that Torita teaches that silicon oxide should be 2-10% of the total mass of silicon oxide plus graphite and NAML thicknesses of 50-250 μ m, overlapping the claimed range. *Id.*, 365-366. The Examiner found Torita further teaches silicon oxide with a Dv50 between 1-20 μ m. *Id.*, 366-367.

51. The Examiner found that Kim (EX1010) teaches that silicon oxide in NAMLs can be in crystalline or amorphous form. EX1002, 367.

52. The Examiner found that Kamizori (EX1011) teaches coating the silicon oxide with a carbon coating layer. EX1002, 368. The Examiner further found Kamizori teaches that a silicon oxide coated with carbon would have peaks in the Raman spectrum at 510 cm^{-1} and 1343 cm^{-1} that must be greater than 0, and consequently their ratio would also inherently be greater than 0. *Id.*

53. The Examiner found that Morimoto and Torita teach binders, including styrene-butadiene rubber. EX1002, 369. Torita further teaches the use of carbon black or acetylene black as conductive agents and specific mass ratios for all the components of the NAML. *Id.*, 369-370. Kondo (EX1013) teaches that these conductive agents increase the conductivity of an electrode. *Id.*, 369.

54. Finally, though Morimoto does not provide an embodiment where Morimoto's battery is used in an electronic device, the Examiner found it would have been obvious to do so. EX1002, 370-371.

55. In response, PO amended the independent claims to add the NAML thickness requirement and to make clear that the second portion is a second portion of the negative current collector. EX1002, 375. PO did not dispute the disclosed subject matter of Examiner's cited references. Instead, PO argued that Morimoto and Torita cannot be combined to teach the independent claims because the Examiner

relied on the thicknesses from Morimoto to meet the claimed ratios of coating weights and compaction densities, but the combination with Torita would alter those thicknesses. *Id.*, 384. Further, PO argued there was no motivation to alter Torita's layers to the configuration of Morimoto, especially as Morimoto's thicknesses already fell within Torita's range (but outside the claimed range). *Id.*, 384-386. PO finally argued that the claimed coating weight ratio had unexpected results. *Id.*, 386-387.

56. The Examiner did not consider PO's arguments but, instead, found the claims allowable because of unexpected results of not just the ratio of coating weights, but the combination of ratio of coating weights and ratio of compaction densities. EX1002, 423-424.

2. Prior Art Never Considered by Examiner

57. None of the references relied upon in the Grounds below were before the Examiner during prosecution of the '129 Application. The prior art discussed in my declaration teaches the combination of ratios of coating weights and compaction densities falling within the claimed range, not just overlapping values. It is therefore my understanding that the "unexpected results" argument is moot. Specifically, Manabe (EX1005) teaches a negative electrode with first and second NAMLs with a coating weight ratio of 0.50 and compaction density ratio of 1.0, values directly in

the middle of the claimed ranges of the key factors contributing to the purported unexpected results.

58. **Manabe (EX1005):** In addition to disclosing the claimed ratios of coating weights and compaction densities, Manabe discloses a negative electrode with the same configuration as that claimed: a first NAML on one side of a first portion and a second NAML on both sides of a second portion. Manabe further discloses that each of the active material layers can have a range of thicknesses that overlaps with the claimed range. Thus, it is my opinion that Manabe renders obvious the independent claims of the '082 Patent. Manabe's description of specific materials included in its NAMLs and their proportions further, in my opinion, render obvious numerous of the dependent claims.

59. **Inaba (EX1007):** Inaba discloses a composition of a NAML that includes silicon-oxide coated by carbon, and graphite. The Dv50 of Inaba's NAML particles falls within the claimed range. Inaba describes coating the silicon-oxide material with carbon such that the ratio of the peak height in Raman Spectroscopy at 510cm^{-1} to the peak height at 1343cm^{-1} is 0.25 or less, also within the claimed range.

60. **Wang (EX1009):** Wang discloses a NAML composition of silicon monoxide and graphite. The Dv50 of Wang's NAML particles falls within the claim range.

VII. SUMMARY OF GROUNDS OF INVALIDITY

61. After analyzing the '082 Patent, prosecution history, prior art, and other documents identified above, it is my opinion that the challenged claims are rendered obvious as follows:

Ground	Claims	Reference(s)
1	1-4, 7-12	U.S. Patent Application Publication No. 2018/0248220 A1 to Noriko Manabe et al. (“Manabe,” EX1005)
2	5, 6	- Manabe - Japanese Patent Publication No. JP 2014-89855 to Inaba et al. (“Inaba,” EX1007)
3	5	- Manabe - Chinese Patent Application CN 109509909 A to Wang et al. (“Wang,” EX1009)

62. It is my understanding that these prior art references are U.S. or foreign patent documents that qualify as prior art under §§ 102(a)(1) and 102(a)(2) even if the '082 Patent is entitled to its earliest claimed priority date.

VIII. GROUND 1: MANABE RENDERS OBVIOUS CLAIMS 1-4, 7-12

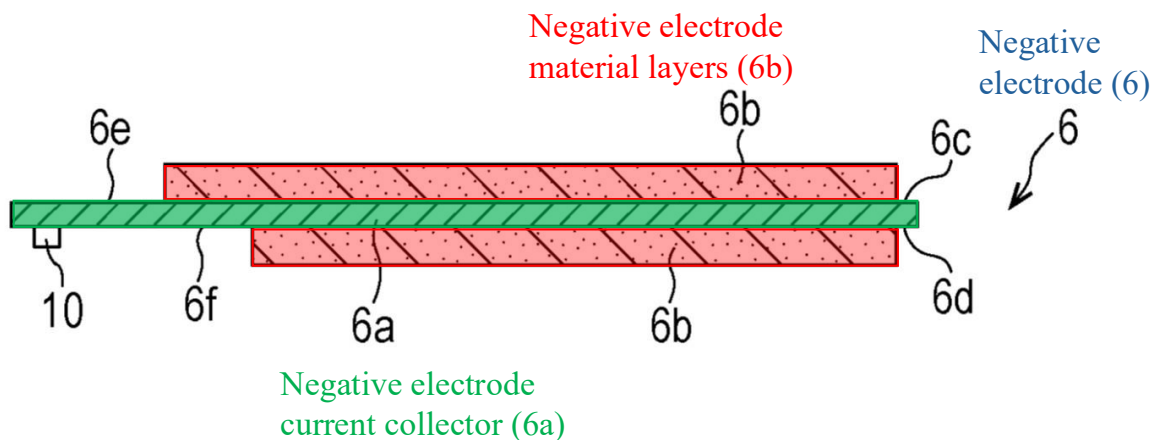
A. Overview of Manabe

63. Manabe is directed to a nonaqueous electrolyte secondary battery which exhibits high capacity, high output, and excellent high-temperature cycle characteristics. EX1005, ¶ [0012]. Example applications of Manabe's battery include power supplies for driving of mobile information terminals such as cellphones, laptop computers and smartphones, power supplies with high capacity and excellent low-temperature characteristics for driving of electric and hybrid vehicles, and storage-related power supplies. *Id.*, ¶ [0126].

64. Manabe's battery includes a positive electrode, negative electrode, and separator. EX1005, ¶¶ [0011], [0023], [0026]-[0029]. The negative electrode includes a negative electrode current collector and negative electrode active material mixture layer comprised of a silicon compound and a carbon material. *Id.* The silicon compound is preferably a SiO_x , where $0.5 \leq x \leq 1.5$. *Id.*, ¶¶ [0017], [0020], [0052]. Further, the silicon compound is preferably between 5-30 mass% of the total mass of the carbon material and silicon compound of the negative electrode mixture layer. *Id.*, ¶¶ [0017], [0021], [0053]. Manabe teaches the silicon compound (SiO_x) in the negative electrode mixture layer expands during charging, which suppresses the swelling of the positive electrode plate and consequently improves the electrical

contact of the positive electrode. EX1005, ¶ [0020]. This improves the performance of the positive electrode and the battery at high-temperatures. *Id.*

65. The following is a schematic, cross-sectional view of Manabe's negative electrode:



EX1005, Fig. 3(b)*

66. Manabe discloses a negative electrode (6) including a long negative electrode current collector (6a) with negative electrode mixture layers (6b) disposed on both sides of the current collector. EX1005, ¶ [0028]. At one end of the current collector, the current collector is exposed equally on both sides (6c and 6d). *Id.* At the other end, one side of the current collector has a longer exposed area (6f) than the opposite side (6e). *Id.* The negative electrode lead (10) is welded to the longer exposed area of the current collector. *Id.*

67. Manabe discloses in detail the structure of its positive electrode. *Id.*, ¶¶ [0030]-[0049]. Manabe further discloses the details of the separator and the electrolyte. *Id.*, ¶¶ [0062]-[0067].

68. Manabe discloses that the negative electrode includes a current collector that can be either a porous or nonporous conductive substrate. EX1005, ¶ [0050]. The thickness of the current collector can range from 3 to 50µm, and most preferably 10 to 20µm. *Id.*, ¶¶ [0030], [0050]. The current collector is made of metal, such as stainless steel, or nickel, but most preferably copper or copper alloy. *Id.*, ¶ [0050]. The negative electrode mixture layer includes a negative electrode active material layer and a binder and may also include a conductive auxiliary and thickener. *Id.*, ¶ [0051]. The negative electrode mixture is applied as a slurry to the surface of the current collector, then rolled and dried to form the negative electrode mixture layer on the current collector. *Id.*

69. The negative electrode active material includes a carbon material and a silicon compound. EX1005, ¶ [0052]. The carbon material is not limited, but Manabe gives examples such as “graphites (including natural graphite, artificial graphite, and graphitized mesophase carbon), cokes, semi-graphitized carbons, carbon fibers, and amorphous carbons.” *Id.* The silicon compounds are not limited, but Manabe identifies silicon oxides and silicides as examples. *Id.* Preferably, silicon

oxides SiO_x (where $0.05 \leq x \leq 1.5$) is the silicon compound. *Id.*⁴ Manabe teaches that SiO_x should be between 2-50 mass% (preferably 5-30 mass%) of the total mass of the carbon material plus the SiO_x . *Id.*, ¶ [0053]. If SiO_x is below that range, there is insufficient SiO_x to expand and thereby improve the contact of the positive electrode, therefore the intended benefit of compressing the positive electrode and improving the electrical contact of the positive electrode is not obtained. *Id.*, ¶ [0054]. If SiO_x is above that range, the expansion and shrinkage experienced during charging and discharging is too great, causing deterioration of the cycle characteristics. *Id.* Manabe further teaches coating the surface of SiO_x with carbon to improve the poor conductivity of SiO_x . *Id.*, ¶ [0055].

70. The binder can be any known binding agent or a combination of binding agents. EX1005, ¶¶ [0044], [0057]. Manabe provides the following examples of binding agents:

⁴ SiO_x is not a single compound but instead represents that the active material has regions of pure Si and regions of pure SiO_2 . Only SiO_2 is properly silicon oxide. But the '082 Patent states, "silicon oxide is represented by the general formula SiO_x , where $0.5 \leq x \leq 1.6$." EX1001, 5:32-33. Therefore, I refer to SiO_x at times as silicon oxide to match the language used in the '082 Patent.

fluororesins such as polytetrafluoroethylene (PTFE), polyvinylidene fluoride (PVDF) and vinylidene fluoride (VDF)-hexafluoropropylene (HFP) copolymer; polyolefin resins such as polyethylene and polypropylene; polyamide resins such as aramid; and rubbery materials such as styrene-butadiene rubber and acrylic rubber.

Id., ¶ [0044]. The binder is no more than 10 mass% of the negative electrode active material, and most preferably less than 3 mass%. *Id.*, ¶¶ [0045], [0057].

71. The dispersion medium for the negative electrode mixture layer is not limited, and can “include water, alcohols such as ethanol, ethers such as tetrahydrofuran, amides such as dimethylformamide, N-methyl-2-pyrrolidone (NMP), and mixtures of these solvents.” EX1005, ¶¶ [0048], [0057].

72. The conductive auxiliaries for the negative electrode mixture layer are not limited, and can include “carbon blacks such as acetylene black, conductive fibers such as carbon fibers and metal fibers, and carbon fluorides.” EX1005, ¶¶ [0042], [0057]. Manabe teaches the conductive auxiliary should be between 0.5-1.5 mass% of the negative electrode mixture layer. *Id.*, ¶¶ [0043], [0057]. Below that range, the discharge characteristics are significantly decreased. *Id.*, ¶ [0043]. Above that range, battery capacity is decreased. *Id.*

73. Manabe provides the following examples of thickeners: “cellulose derivatives such as carboxymethylcellulose (CMC); C2-4 polyalkylene glycols such

as polyethylene glycol and ethylene oxide-propylene oxide copolymer; polyvinyl alcohols; and solubilized modified rubbers.” EX1005, ¶¶ [0046], [0057]. The amount of thickener is not limited but is preferably between 0.01-5 mass%. *Id.*, ¶ [0047]. Manabe’s thickeners are polymeric compounds that modify the viscosity of the slurry but also participate in binding the active material layers. In this sense Manabe’s thickeners, when present, comprise part of the binder claimed in the ’082 Patent.

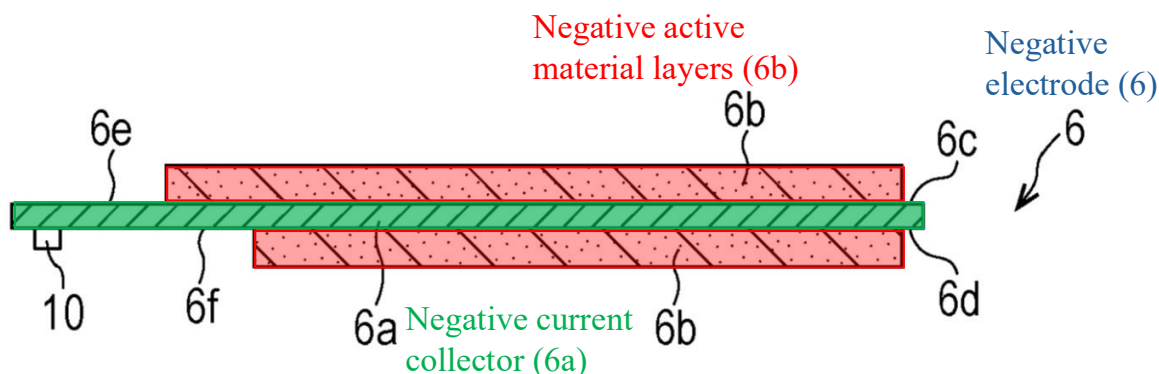
74. Manabe discloses the thickness of the negative electrode mixture layers is preferably 40-120µm per side of the negative electrode current collector. EX1005, ¶ [0058]. The density of the negative electrode active material is preferably 1.3-1.9g/cm³. *Id.*

75. Manabe’s various experiments illustrate the effectiveness of its battery design. EX1005, ¶¶ [0070]-[0125]. Table 1 confirms the presence of SiO_x in the negative electrode contributes to improved high-temperature cycle characteristics and increased capacity retention. *Id.*, Table 1, ¶ [0088]. Table 5 confirms increasing the mass% of SiO_x increases the ratio of expansion after charging, thus increasing the compression effect on the positive electrode. *Id.*, Table 5, ¶ [0110].

B. Independent Claim 1

1. [1.pre]⁵: “A negative electrode, comprising:”

76. Manabe discloses or suggests this element. Specifically, Manabe discloses a nonaqueous electrolyte secondary battery that includes a *negative electrode* (negative electrode 6):



EX1005, Fig. 3(b)*

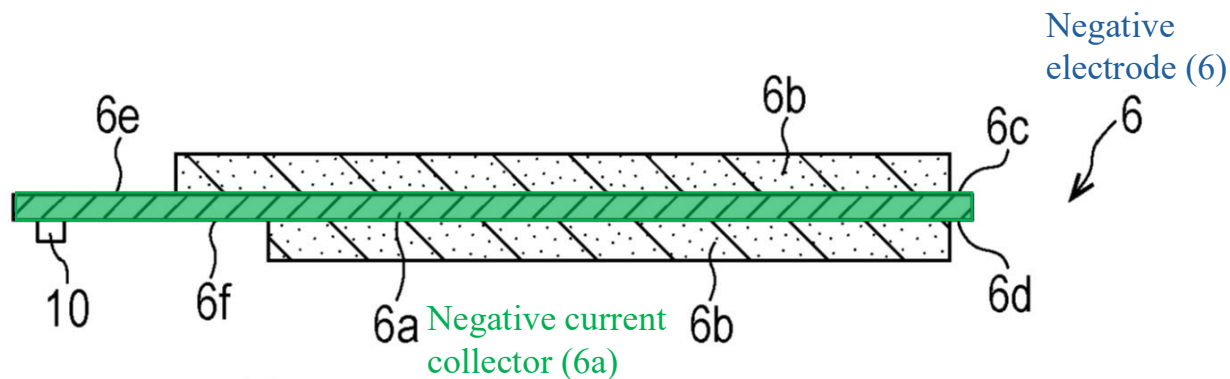
77. Manabe discloses “a nonaqueous electrolyte secondary battery which includes an electrode assembly that includes a...negative electrode including a negative electrode current collector and a negative electrode mixture layer.” EX1005, Abstract; *see also id.*, ¶¶ [0011], [0015], [0017], [0028], [0050]-[0061]. Figures 3(a)-(c) provide schematics of the negative electrode. *Id.*, FIGS. 3(a)-(c), ¶ [0015]. Manabe describes specific compositions of the negative electrode,

⁵ I’ve labeled each claim element with a bracketed number for ease of reference.

including specific components of the active material layer, and the dimensions and/or proportions of the components of the negative electrode. *Id.*, ¶¶ [0050]-[0061]. Manabe further provides multiple examples of batteries including negative electrodes. EX1005, ¶¶ [0070]-[0081].

2. [1.1]: “a negative current collector”

78. Manabe discloses or suggests this element. Specifically, Manabe’s negative electrode includes a *negative current collector* (negative electrode current collector 6a):



EX1005, FIG. 3(b)*

79. Manabe discloses the “negative electrode 6 includes a long negative electrode current collector 6a, and negative electrode mixture layers 6b disposed on both sides of the negative electrode current collector 6a.” EX1005, ¶ [0028]. The negative current collector may be a nonporous or porous conductive substrate with a thickness ranging from 3 to 50 μ m. *Id.*, ¶¶ [0030], [0050]. The negative current

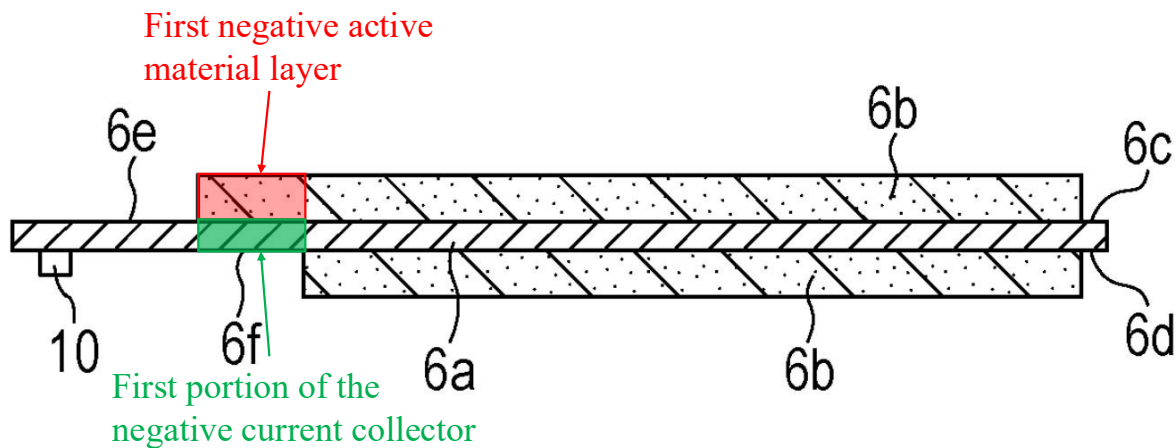
collector is made of metal, such as stainless steel, nickel, copper, and copper alloys.

Id., ¶ [0050]. Similarly, the '082 Patent's negative current collector is copper.

EX1001, 6:61-62.

3. [1.2]: “a first negative active material layer, wherein the first negative active material layer is arranged on one side of a first portion of the negative current collector; and”

80. In my opinion, Manabe discloses or suggests this element. Specifically, Manabe's negative electrode has a *first negative active material layer* (negative electrode mixture layer 6b) *arranged on one side* (top side only) *of a first portion* (highlighted single-sided-coated portion) *of the negative current collector* (negative electrode current collector 6a):



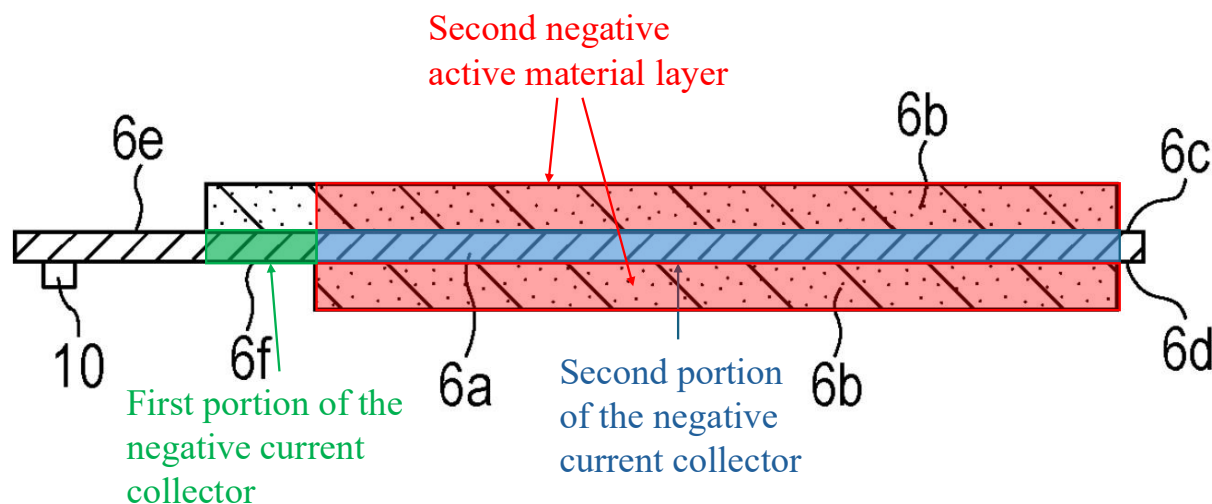
EX1005, Fig. 3(b)*

81. Manabe discloses the negative electrode has “negative electrode mixture layers 6b disposed on both sides of the negative electrode current collector

6a.” EX1005, ¶ [0028]. Manabe explains that “portions 6e and 6f” of the negative current collector are “exposed” without any NAML coating. *Id.* As can be seen in Figure 3(b) above, “the exposed portion 6f...extends farther than the exposed portion 6e.” *Id.*; *see also id.*, ¶ [0074] (“portion 6e...having a width of 23.0 mm was exposed on one side, and a portion 6f...having a width of 76.0 mm was exposed on the other side.”). Therefore, a portion of the negative current collector has the first NAML coated on only one side. The first active material layer corresponding to element 1.2 is highlighted in red above. Thus, it is my opinion that Manabe discloses this claim element.

4. [1.3]: “a second negative active material layer, wherein the second negative active material layer is arranged on two sides of a second portion of the negative current collector, wherein the second portion of the negative current collector is different from the first portion of the negative current collector;”

82. In my opinion, Manabe discloses or suggests this element. Specifically, Manabe’s negative electrode has a *second negative active material layer* (negative electrode mixture layer 6b) *arranged on two sides* (top and bottom) *of a second portion* (highlighted double-sided-coated portion) *of the negative current collector* (negative electrode current collector 6a) that is *different from the first portion* (highlighted single-sided-coated portion):



EX1005, Fig. 3(b)*

83. Manabe discloses the negative electrode has “negative electrode mixture layers 6b disposed on both sides of the negative electrode current collector 6a.” EX1005, ¶¶ [0028], [0074]. As illustrated above, the blue-highlighted second portion of the negative current collector—different from the green-highlighted first portion—has NAML coated on two sides. The second active material layer corresponding to element 1.3 is highlighted in red above. Thus, it is my opinion that Manabe discloses or suggests this claim element.

5. [1.4]: “wherein a ratio of a weight per unit area of the first negative active material layer to a weight per unit area of the second negative active material layer on the negative current collector is 0.47 to 0.52, and”

84. In my opinion, Manabe discloses or inherently suggests this element. Specifically, Manabe discloses a *ratio of a weight per unit area of the first negative*

active material layer (negative electrode mixture layers 6b) to a weight per unit area of the second negative active material layer (negative electrode mixture layers 6b) on the negative current collector (negative electrode current collector 6a) between 0.47 to 0.52 (0.5).

85. Manabe inherently discloses the weight per unit area (i.e., coating weight) of its NAMLs. First, coat weight may be determined by multiplying the compaction density of the NAML by its thickness. Manabe teaches the thickness and compaction densities of the NAMLs. EX1005, ¶ [0058]. With these properties known, the coating weight – and therefore the ratio of the coating weights – is readily determined by multiplying the compaction density by the thickness. Thus, the ratio of coating weights is as follows: Ratio = ((First NAML density) x (First NAML thickness)) ÷ ((Second NAML density) x (Second NAML thickness)).

86. Second, Manabe teaches that the compaction density and thickness is the same for both the first and second NAMLs. Specifically, Manabe teaches the “density of the active material in the negative electrode mixture layers is preferably 1.3 to 1.9 g/cm³” and the “the thickness of the negative electrode mixture layers is preferably 40 to 120µm...per side of the negative electrode current collector.”

EX1005, ¶ [0058].⁶ Therefore, it is my opinion a POSITA would understand the disclosed density and thickness values to apply equally to each coated side of the negative electrode current collector. With the same density and thickness per side, and the second NAML having two sides of active material, the math simplifies to: $\text{Ratio} = ((\text{NAML thickness}) \times (1 \text{ side})) \div ((\text{NAML thickness}) \times (2 \text{ sides}))$. Therefore, Manabe's ratio of the weight per unit area of the first NAML to the second NAML is 0.5, disclosing this claim element.

87. Manabe's examples confirm the disclosed 0.5 ratio of coating weights. For Example 1, Manabe states the "thickness" of the NAMLs is "77.3 μm per side" and the "density was 1.65 g/cm^3 ." EX1005, ¶[0074]. Thus, the coating weight for the first NAML is 12.75 mg/cm^2 ($77.3 \mu\text{m} \times 1.65\text{g}/\text{cm}^3 = 0.01275\text{g}/\text{cm}^2$) and the coating weight for the second NAML is 25.5 mg/cm^2 ($77.3 \mu\text{m} \times 2 \times 1.65\text{g}/\text{cm}^3 = 0.0255\text{g}/\text{cm}^2$), resulting in a ratio of 0.5 ($12.75 \text{ mg}/\text{cm}^2 \div 25.5 \text{ mg}/\text{cm}^2 = 0.5$).

88. Similarly, Example 2 has a thickness of "80.5 μm per side" and the "density was 1.60 g/cm^3 ." EX1005, ¶[0078]. Thus, the coating weight for the first NAML is 12.88 mg/cm^2 ($80.5 \mu\text{m} \times 1.60\text{g}/\text{cm}^3 = 0.01288\text{g}/\text{cm}^2$) and the coating

⁶ All emphases through my declaration have been added unless otherwise stated.

weight for the second NAML is 25.76 mg/cm^2 ($80.5 \text{ } \mu\text{m} \times 2 \times 1.60\text{g/cm}^3 = 0.02576\text{g/cm}^2$), resulting in a ratio of 0.5 ($12.88 \text{ mg/cm}^2 \div 25.76 \text{ mg/cm}^2 = 0.5$).

89. Finally, Example 3's thickness is "76.5 μm per side" and the compaction density is the same as Example 1: 1.65 g/cm^3 . EX1005, ¶ [0079] ("battery was fabricated in the same manner as in EXAMPLE 1" except for noted changes). Thus, the coating weight for the first NAML is 12.62 mg/cm^2 ($76.5 \text{ } \mu\text{m} \times 1.65\text{g/cm}^3 = 0.01262\text{g/cm}^2$) and the coating weight for the second NAML is 25.24 mg/cm^2 ($76.5 \text{ } \mu\text{m} \times 2 \times 1.65\text{g/cm}^3 = 0.02524\text{g/cm}^2$), resulting in a ratio of 0.5 ($12.62 \text{ mg/cm}^2 \div 25.24 \text{ mg/cm}^2 = 0.5$).

90. Therefore, it is my opinion that Manabe teaches this claim element.

6. [1.5]: "a ratio of a compacted density of the first negative active material layer to a compacted density of the second negative active material layer is 0.9 to 1.1;"

91. In my opinion, Manabe discloses or suggests this element. Specifically, Manabe discloses a *ratio of a compacted density (density) of the first negative active material layer (negative electrode mixture layers 6b) to a compacted density (density) of the second negative active material layer (negative electrode mixture layers 6b) between 0.9 to 1.1 (1.0)*.

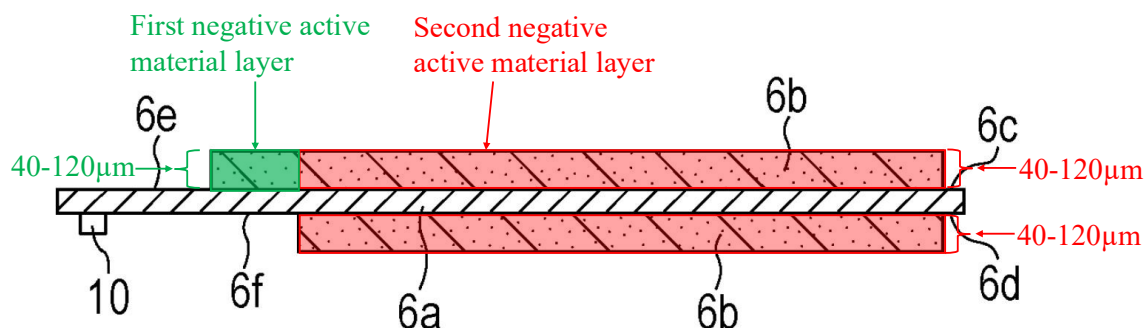
92. As explained above, Manabe discloses that the density (i.e., *compacted density*)⁷ of the negative electrode mixture layers is uniform. *Supra* Section VIII.B.5. Specifically, Manabe teaches the “density of the active material in the negative electrode mixture layers is preferably 1.3 to 1.9 g/cm³.” EX1005, ¶ [0058]. Manabe applies this density parameter to the negative electrode mixture layers generally and does not disclose any difference in density between the first and second NAMLs. Accordingly, a POSITA would understand the disclosed single compaction density applies equally to both the first and second NAMLs. Manabe’s examples confirm that a single compaction density applies to both NAMLs of the negative electrode taught by Manabe. *Id.*, ¶¶ [0074] (Example 1 has a single compaction density of 1.65 g/cm³), [0078] (Example 2 has a single compaction density of 1.60 g/cm³), [0079] (Example 3 has the same single compaction density of Example 1: 1.65 g/cm³). As the density is uniform throughout the NAMLs, the ratio of the compacted density of

⁷ “Compacted density” is the density of the NAML in the final negative electrode, after the NAML has been cold-pressed to the surface of the current collector. EX1001, 4:47-41. Manabe discloses that its negative electrode mixture layer is formed by rolling (i.e., via a rolling press) the negative electrode mixture slurry on the surface of the current collector. EX1005, ¶[0051]. Therefore, the density of Manabe’s negative electrode mixture layer is the “compacted density.”

the first NAML to the second NAML is 1.0. Thus, it is my opinion that Manabe discloses this claim element.

7. [1.6]: “wherein a thickness of the first negative active material layer is 40 μm to 60 μm , and a thickness of the second negative active material layer on each of the two sides of the second portion is 40 μm to 60 μm .”

93. In my opinion, Manabe discloses or suggests this element. Specifically, Manabe discloses that the *thickness of the first negative active material layer* (negative electrode mixture layer 6b, highlighted in green) *and the second negative active material layer* (negative electrode mixture layers 6b, highlighted in red) *on each of the two sides of the second portion* can be 40 μm to 60 μm (40 to 120 μm):



EX1005, Fig. 3(b)*

94. Figure 3(b), as annotated above, demonstrates that the thickness of the first NAML is the same as the thickness of one side of the second NAML, which is the same thickness as the second NAML on the opposite side of the current collector. This is confirmed by Manabe’s general description: “the thickness of the negative electrode mixture layers is preferably 40 to 120 μm ...per side of the negative

electrode current collector.” EX1005, ¶ [0058]. Manabe’s examples further confirm that the NAML on both sides of the current collector have uniform thickness. *See* Section VIII.B.5 (citing EX1005, ¶¶ [0074], [0078], [0079]). Therefore, Manabe’s disclosed thickness range of “40 to 120 μm ...per side” applies to both the first NAML and each of the two sides of the second NAML.

95. It is my understanding that because Manabe’s disclosed range of thicknesses overlaps with the claimed range, this claim element is rendered obvious.

C. Dependent Claim 2

1. [2.1]: “The negative electrode according to claim 1, the weight per unit area of the first negative active material layer on the first portion is 65 g/m^2 to 130 g/m^2 , and the weight per unit area of the second negative active material layer on the second portion is 130 g/m^2 to 260 g/m^2 .”

96. It is my opinion that Manabe discloses or suggests this claim. Specifically, Manabe discloses the *weight per unit area of the first negative active material layer* (negative electrode mixture layers 6b) *on the first portion* can be between 65 g/m^2 to 130 g/m^2 (52-228 g/m^2) and the *weight per unit area of the second negative active material layer* (negative electrode mixture layers 6b) *on the second portion* can be between 130 g/m^2 to 260 g/m^2 (104-456 g/m^2).

97. As explained, Manabe does not expressly disclose the coating weights of the NAMLs but does disclose the thickness and compaction densities which

directly yield the coating weights. *See* Section VIII.B.5. Further, the thickness of the first NAML is the same as thickness of each individual side of the second NAML (*see* Section VIII.B.7) and the compaction density is uniform throughout (*see* Section VIII.B.6). Manabe discloses that the density ranges from 1.3-1.9 g/cm³ and the thickness ranges from 40-120 μm per side. EX1005, ¶[0058]. Therefore, Manabe discloses a range of coating weights of 52-228 g/m² per side (1.3 g/cm³ x 40 μm = 52g/m²; 1.9 g/cm³ x 120 μm = 228g/m²). As the first NAML is coated only on one side of the negative current collector, its coating weight is 52-228 g/m². As the second NAML is coated on both sides of the negative current collector, its coating weight is double: 104-456 g/m². Thus, Manabe discloses coating weight ranges overlapping the claimed ranges.

D. Dependent Claim 3

1. [3.1]: “The negative electrode according to claim 1, wherein the first negative active material layer and the second negative active material layer each independently comprise a silicon-based material and graphite, wherein the silicon-based material is selected from the group consisting of silicon oxide, silicon carbon, and a combination thereof.”

98. Manabe discloses or suggests this claim. Specifically, Manabe discloses the *first negative active material layer* (negative electrode mixture layers 6b) and *second negative active material layer* (negative electrode mixture layers 6b) *each independently comprise a silicon-based material* (silicon compound) and

graphite (carbon material, graphite, natural graphite, artificial graphite, graphitized mesophase carbon) and the *silicon-based material* (silicon compound) is *silicon oxide* (silicon oxide, SiO_x).

99. **The first negative active material layer and the second negative active material layer each independently comprise:** Manabe discloses a single negative electrode active material used to coat both sides of the negative current collector. EX1005, ¶¶[0011] (describing “[t]he negative electrode mixture layer” used in the negative electrode); [0073] (“the negative electrode mixture slurry was applied to *both sides* of a...current collector.”); *see also* Section VIII.B.5 (density and thickness are the same per side for the first and second NAMLs). Thus, Manabe’s first NAML and second NAML each comprise the same disclosed negative electrode active material.

100. **Graphite:** Manabe discloses the “negative electrode active material includes a carbon material.” EX1005, ¶[0052]. The carbon material can be “graphites (such as natural graphite, artificial graphite and graphitized mesophase carbon).” *Id.* Therefore, Manabe discloses both the first NAML and second NAML comprise graphite.

101. **Silicon compound is silicon oxide:** Manabe discloses the “negative electrode active material includes ... a silicon compound.” EX1005, ¶[0052]. The silicon compound can be “silicon and silicon-containing compounds such as silicon

oxides SiO_x ($0.05 < x < 1.95$) and silicides” and is “preferably SiO_x ($0.5 \leq x \leq 1.5$).” *Id.*

Therefore, it is my opinion that Manabe teaches claim 3.

E. Dependent Claim 4

- 1. [4.1]: “The negative electrode according to claim 3, wherein a weight of the silicon-based material in the first negative active material layer and the second negative active material layer is greater than or equal to 5% and less than 100%, based on a total weight of the silicon-based material and the graphite.”**

102. In my opinion, Manabe discloses or suggests this claim. Specifically, Manabe discloses the *weight (mass %) of the silicon-based material* (silicon compound, silicon oxide, SiO_x) *is greater than or equal to 5% (not less than 5 mass %) and less than 100% (less than 30 mass %) based on a total weight of the silicon-based material and the graphite* (carbon material, graphite, natural graphite, artificial graphite, graphitized mesophase carbon).

103. As explained above, Manabe discloses the use of the same negative electrode active material for both the first and second NAMLs. *See* Section VIII.D.1. Manabe further discloses that in order to “attain enhancements in cycle characteristics and battery safety,” silicon oxide preferably comprises between 2-50% “of the total mass of the carbon material and SiO_x taken as 100 mass %.” EX1005, ¶[0053]. More preferably, silicon oxide is “not less than 5 mass % and less than 30 mass %.” *Id.* Manabe’s preferred range substantially overlaps the claimed

range and Manabe's more preferred range falls squarely within the claimed range.

Thus, in my opinion, Manabe discloses this element.

F. Dependent Claim 7

- 1. [7.1]: "The negative electrode according to claim 3, wherein the silicon-based material further comprises a carbon coating layer."**

104. Manabe discloses or suggests this claim. Specifically, Manabe discloses the *silicon-based material* (silicon oxide, SiO_x) *further comprises a carbon coating layer* (coated with carbon). Manabe discloses "[t]he surface of SiO_x may be coated with carbon. Because the SiO_x is poorly conductive to electrons, an increase in electron conductivity may be obtained by coating the surface with carbon."

EX1005, ¶[0055]. Thus, it is my opinion that Manabe discloses this element.

G. Dependent Claim 8

- 1. [8.1]: "The negative electrode according to claim 3, wherein the first negative active material layer and the second negative active material layer each independently comprise a binder and a conductive agent;"**

105. Manabe discloses or suggests this claim element. Specifically, Manabe discloses the *first negative active material layer* (negative electrode mixture layers 6b) *and second NAML* (negative electrode mixture layers 6b) *each independently comprise a binder* (binder, binding agent) *and a conductive agent* (conductive auxiliary).

106. As explained above, Manabe uses the same negative electrode mixture layer for both the first and second NAMLS. *See* Section VIII.D.1. Manabe further discloses the negative electrode mixture layers contain, in addition to the active materials, a “binder.” EX1005, ¶[0051]. Additionally, Manabe discloses “additives such as a conductive auxiliary” (i.e., conductive agent) can be added to the negative electrode mixture layers. *Id.* Thus, it is my opinion that Manabe discloses this element.

2. [8.2]: “wherein the binder comprises a material selected from the group consisting of polyacrylate, polyimide, polyamide, polyamideimide, polyvinylidene fluoride, styrene-butadiene rubber, sodium alginate, polyvinyl alcohol, polytetrafluoroethylene, polyacrylonitrile, sodium carboxymethyl cellulose, potassium carboxymethyl cellulose, and a combination thereof; and”

107. Manabe discloses or suggests this claim. Specifically, Manabe discloses the *binder* (binder) can be *polytetrafluoroethylene* (polytetrafluoroethylene, PTFE), *polyvinylidene fluoride* (polyvinylidene fluoride, PVDF), *styrene-butadiene rubber* (styrene-butadiene rubber), or a combination thereof.

108. Manabe discloses the binder can be any “known binding agent,” and lists examples including

fluororesins such as **polytetrafluoroethylene (PTFE)**, **polyvinylidene fluoride (PVDF)** and vinylidene fluoride

(VDF)-hexafluoropropylene (HFP) copolymer; polyolefin resins such as polyethylene and polypropylene; polyamide resins such as aramid; and rubbery materials such as **styrene-butadiene rubber** and acrylic rubber.

EX1005, ¶[0044].⁸ Manabe further discloses the “binders may be used singly, or two or more may be used in combination.” *Id.* Thus, Manabe discloses this element.

3. [8.3]: “the conductive agent comprises a material selected from the group consisting of conductive carbon black, acetylene black, Ketjen black, graphene, and a combination thereof.”

109. Manabe discloses or suggests this claim. Specifically, Manabe discloses the *conductive agent* (conductive auxiliary) *comprises a material selected from the group consisting of conductive carbon black* (carbon blacks), *acetylene black* (acetylene black), *and a combination thereof*.

110. Manabe discloses the conductive agent can be any “known material,” and lists examples including “**carbon blacks** such as **acetylene black**; conductive fibers such as carbon fibers and metal fibers; and carbon fluorides.” EX1005,

⁸ This disclosure is in reference to the binders used in the positive electrode mixture layer, but Manabe teaches using the same binders in the negative electrode mixture layers. EX1005, ¶[0057].

¶[0042].⁹ Manabe further discloses the “conductive auxiliaries may be used singly, or two or more may be used in combination.” *Id.* Therefore, Manabe discloses this element.

H. Dependent Claim 9

1. [9.1]: “The negative electrode according to claim 8, wherein based on a total weight of the first negative active material layer, the total weight of the silicon-based material and the graphite in the first negative active material layer is 94% to 96%, a weight of the binder is 2.8% to 5.0%, and a weight of the conductive agent is 0.4% to 1.6%; and based on a total weight of the second negative active material layer, the total weight of the silicon-based material and the graphite in the second negative active material layer is 94% to 96%, the weight of the binder is 2.8% to 4.0%, and the weight of the conductive agent is 0.4% to 1.6%.”

111. In my opinion, Manabe discloses or suggests this claim. Specifically, Manabe discloses that, *based on a total weight (mass) of the first negative active material layer (negative electrode mixture layers 6b), the total weight (mass %) of the silicon-based material (silicon oxide, SiO_x) and the graphite (graphite) (collectively, negative electrode active material) in the first negative active material*

⁹ This disclosure is in reference to the conductive auxiliaries used in the positive electrode mixture layer, but Manabe teaches using the same conductive auxiliaries in the negative electrode mixture layers. EX1005, ¶[0057].

layer can be between 94% to 96% (82.3% to 99.5% or 89.7% to 99.5%), a weight (mass) of the binder (binder) can be between 2.8% to 5.0% (0.01% to 4.74%), and a weight of the conductive agent (conductive auxiliary) can be between 0.4% to 1.6% (0.41% to 1.48%). Further, Manabe discloses that, based on a total weight of the second NAML (negative electrode mixture layers 6b), the total weight of the silicon-based material and the graphite in the second NAML can be between 94% to 96% (82.3% to 99.5% or 89.7% to 99.5%), the weight of the binder can be between 2.8% to 4.0% (0.01% to 4.74%), and the weight of the conductive agent can be between 0.4% to 1.6% (0.41% to 1.48%).

112. Manabe specifies the amount of conductive material as follows: “The content of the conductive auxiliary in the... electrode mixture layer is preferably not less than 0.5 mass % and not more than 1.5 mass % relative to the... electrode active material taken as 100 mass %.” EX1005, ¶¶ [0043], [0057]. This statement appears to be teaching a range for the mass ratio of the conductive material to the active material (graphite and silicon compounds), expressed as a percentage (i.e., multiplied by 100%). This value is distinct from the mass % of the conductive additive in the electrode layer, expressed relative to all the components of the electrode layer (at least active material, plus binder, plus conductive additive).

113. Manabe specifies a range for the amount of binder: “The content of the binder in the positive electrode mixture layer is appropriately, for example, not more

than 10 mass % relative to the positive electrode active material taken as 100 mass %.” EX1005, ¶¶ [0045], [0057]. Manabe also gives a preferred range: “[T]he amount of the binder is preferably not more than 5 mass %, and more preferably not more than 3 mass %. The lower limit of the content of the binder is not particularly limited, and the amount may be, for example, 0.01 mass% or less relative to the... electrode active material taken as 100 mass %.” *Id.* This statement teaches a range for the mass ratio of the binder to the active material (graphite and silicon compounds), expressed as a percentage (i.e., multiplied by 100%). This value is distinct from the mass % of the binder in the electrode layer, expressed relative to all the components of the electrode layer (at least active material, plus binder, plus conductive additive).

114. Manabe specifies a range as well as a preferred range for the amount of thickener as follows: “The proportion of the thickener is not particularly limited, but is preferably, for example, not less than 0 mass% and not more than 10 mass %, and more preferably not less than 0.01 mass % and not more than 5 mass % relative to the positive electrode active material taken as 100 mass%.” EX1005, ¶¶ [0047], [0057]. This statement teaches a range for the mass ratio of the thickener to the active material (graphite and silicon compounds), expressed as a percentage (i.e., multiplied by 100%). This value is distinct from the mass % of the thickener in the electrode layer, expressed relative to all the components of the electrode layer (active material, plus binder, plus conductive additive, plus thickener). Manabe specifies

“thickeners” as distinct from “binders.” *Id.*, ¶¶ [0044], [0046]. However, a POSITA would recognize that the thickeners taught by Manabe are all polymers that remain in the electrode layer and participate in the binding of the active material. Manabe is calling out a specific subset of binders and referring to them as thickeners, no doubt because they are more effective at modifying the coating slurry viscosity than other polymers on Manabe’s binder list. Note that carboxymethylcellulose (CMC) and polyvinyl alcohol, which are taught as thickeners by Manabe (EX1005, ¶ [0046]), are listed by the ’082 Patent as binders. EX1001, 6:26-35, Claim 8.

115. The correspondence of binders and thickeners in Manabe is further emphasized by the fact that Manabe teaches the same ranges for their compositions in the electrode layer: The broadest teaching for both binder and thickener is 0 to 10 mass%, and the preferred range for both binder and thickener is 0.01 to 5 mass %, based on the active material as 100%. EX1005, ¶¶ [0045], [0047]. It is possible that the binder and thickener composition ranges are independent of one another, in which case Manabe teaches that the total binder plus thickener could be as much as 20 mass % or preferably as much as 10 mass %. However, a POSITA would recognize that Manabe’s thickeners are actually just other binders, and they could interpret the correspondence of the composition ranges as an indication that the binder plus thickener together should be in a range of up to 10 mass % or preferably up to 5 mass %.

116. The '082 Patent claims negative electrode layer compositions based on the weight (i.e., mass) percentages of active material, binder and conductive additive expressed relative to the total mass of everything in the electrode layer. To the extent that Manabe teaches compositions of binder, conductive additive, and thickener relative to the active material only, a simple calculation (well within the skills of a POSITA) is needed to convert Manabe's teachings to the percentage basis in which the '082 Patent claim is expressed. The results of these calculations are given in the tables below for the various scenarios taught by Manabe.

117. If a POSITA interprets the binder and thickener compositions to be independent of one another then the calculation results are shown in the following tables for both the broader general composition ranges of binder and thickener as well as for the narrower preferred composition ranges of the binder and thickener.

BINDER AND THICKENER SEPARATE						
BROAD RANGE (0 TO 10 MASS%)						
	Minimum (%)	Maximum (%)	Min Mass (g)	Max Mass (g)	Layer Min (%)	Layer Max (%)
Active Material (graphite + silicon)	100.00%	100.00%	100.00	100.00	82.30%	99.50%
Binder	0.00%	10.00%	0.00	10.00	0.00%	9.05%
Conductive Additive	0.50%	1.50%	0.50	1.50	0.41%	1.48%
Thickener	0.00%	10.00%	0.00	10.00	0.00%	9.05%
PREFERRED RANGE (0.01 TO 5 MASS%)						
	Minimum (%)	Maximum (%)	Min Mass (g)	Max Mass (g)	Layer Min (%)	Layer Max (%)
Active Material (graphite + silicon)	100.00%	100.00%	100.00	100.00	89.69%	99.48%
Binder	0.01%	5.00%	0.01	5.00	0.01%	4.74%
Conductive Additive	0.50%	1.50%	0.50	1.50	0.45%	1.48%
Thickener	0.01%	5.00%	0.01	5.00	0.01%	4.74%

118. The first two columns of numerical values specify the minimum and maximum values of the ranges taught by Manabe, relative to the active material as

100%. The second two columns convert these percentages into masses of the various components based on a calculational basis that assumes 100g of the active material. The assumption of this basis amount is for the purposes of the calculation of final percentages of the components in the layer. The percentages thus calculated do not depend on the choice of this basis amount. The final two columns give the minimum and maximum mass percentages of each component relative to all the material in the electrode layer (active material, binder, conductive additive, and thickener). As an example of how these values were calculated, the minimum mass% of binder in the electrode layer is found by dividing the minimum amount of binder (column 3) by the sum of the same minimum amount of binder added to the maximum amounts of the other components (column 4) in the layer. This fraction is then multiplied by 100% to give a percentage. The maximum mass % of binder in the electrode layer is found by dividing the maximum amount of binder (column 4) by the sum of the same maximum amount of binder added to the minimum amounts of the other components (column 3) in the layer. This fraction is then multiplied by 100% to give a percentage. The minimum and maximum mass % of other components (active material, conductive additive, and thickener) in the electrode layer are obtained by analogous calculations, noting that the minimum and maximum amounts of the active material are the same, both 100g. The variation of the mass % of the active

material in the electrode layer comes about from the different amounts of the other materials present in the various scenarios.

119. If alternatively, a POSITA interprets the teachings of Manabe to combine the binder and thickener into a single component in the combined amount specified by the ranges given for both binder and thickener, then the teachings of Manabe produce the following mass percentages for components of the electrode layer, relative to the mass of all materials in the layer.

BINDER AND THICKENER COMBINED						
BROAD RANGE (0 TO 10 MASS%)						
	Minimum (%)	Maximum (%)	Min Mass (g)	Max Mass (g)	Layer Min (%)	Layer Max (%)
Active Material (graphite + silicon)	100.00%	100.00%	100.00	100.00	89.69%	99.50%
Binder (including thickener)	0.00%	10.00%	0.00	10.00	0.00%	9.05%
Conductive Additive	0.50%	1.50%	0.50	1.50	0.45%	1.48%
PREFERRED RANGE (0.01 TO 5 MASS%)						
	Minimum (%)	Maximum (%)	Min Mass (g)	Max Mass (g)	Layer Min (%)	Layer Max (%)
Active Material (graphite + silicon)	100.00%	100.00%	100.00	100.00	93.90%	99.49%
Binder (including thickener)	0.01%	5.00%	0.01	5.00	0.01%	4.74%
Conductive Additive	0.50%	1.50%	0.50	1.50	0.47%	1.48%

120. As explained above, Manabe uses the same negative electrode mixture layer for both the first and second NAMLs. *See* Section VIII.D.1. Therefore, the ratio of components for the first and second NAMLs is the same.

121. **Binder:** Manabe discloses the binder's lower limit "is not particularly limited" and may be as low as 0.01 mass % and is "preferably not more than 5 mass %...relative to the [negative] electrode active material taken as 100 mass %."

EX1005, ¶[0045].¹⁰ In terms of a percentage of the total weight of the NAML, this equates to 0.01% to 4.74%. Thus, it is my opinion that Manabe discloses a binder amount substantially overlapping the claimed ranges for both the first NAML and the second NAML.

122. **Conductive agent:** Manabe discloses the conductive auxiliary is “preferably not less 0.5 mass % and not more than 1.5 mass %.” EX1005, ¶[0043]. In terms of a percentage of the total weight of the NAML, this equates to 0.41% to 1.48% (binder and thickener separate, broadest binder composition range) or 0.47% to 1.48% (binder and thickener combined, preferred binder composition range). Thus, it is my opinion that Manabe discloses a conductive agent substantially overlapping the claimed ranges for both the first NAML and the second NAML.

123. If each of the other components besides the active material (i.e., binder, conductive agent, and thickener) is present in the negative electrode mixture layer at its highest preferred mass %, and the thickener is accounted for independently of the binder, then the mass % of active material (silicon-based material and graphite) is

¹⁰ Manabe explains that the “amounts of the components” including binder and conductive auxiliaries “relative to the negative electrode active material may be selected from the same ranges as mentioned with respect to the positive electrode.” EX1005, ¶[0057].

89.69 mass %. If each of the other components besides the active material (i.e., binder, conductive agent, and thickener) is present at its lowest preferred mass %, and the thickener is accounted for independently of the binder, then the silicon-based material and graphite are 99.5 mass %. Alternatively, if Manabe's disclosure is interpreted to mean that the binder and thickener are a single component and thus the composition range applies to them collectively, then in the preferred composition range the maximum active material percentage is 99.5 mass %, and the minimum active material percentage is 93.90 mass %. Either way, it is my opinion that Manabe discloses component ranges that overlap the claimed ranges, rendering this claim obvious.

I. Independent Claim 10

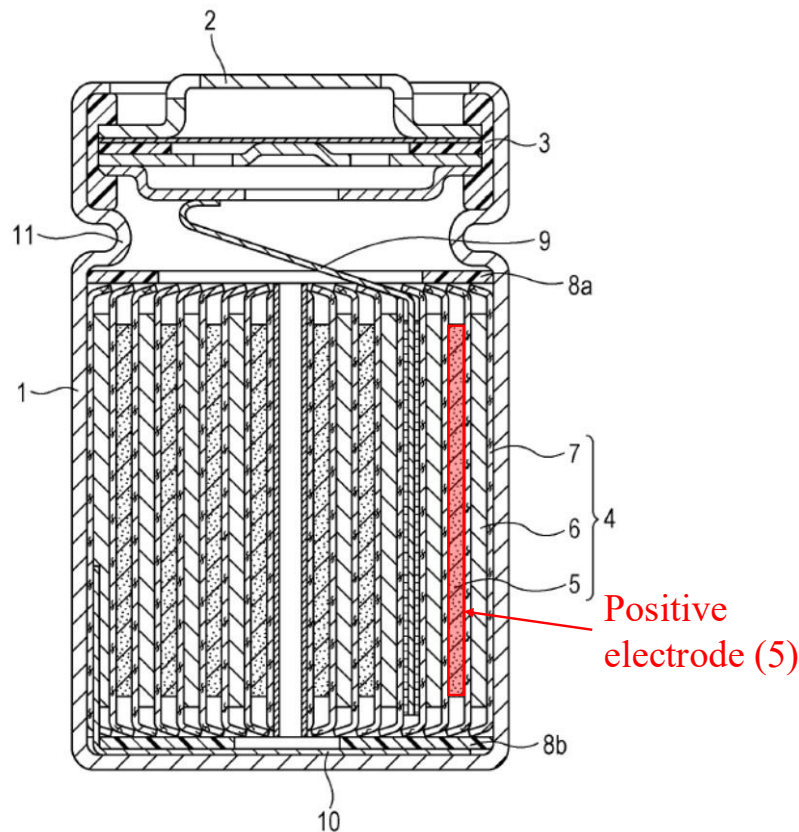
1. [10.pre]: "An electrochemical apparatus, comprising:"

124. Manabe discloses or suggests this claim element. Specifically, Manabe discloses an *electrochemical apparatus* (nonaqueous electrolyte secondary battery).

125. Manabe's invention is directed to a "nonaqueous electrolyte secondary battery." EX1005, Abstract, ¶¶[0010]-[0012]. Nonaqueous electrolyte secondary batteries include lithium-ion batteries, which is the electrochemical apparatus the '082 Patent is directed to. EX1001, 7:15-19.

2. [10.1]: “a positive electrode;”

126. Manabe discloses or suggests this claim element. Specifically, Manabe discloses a *positive electrode* (positive electrode 5):



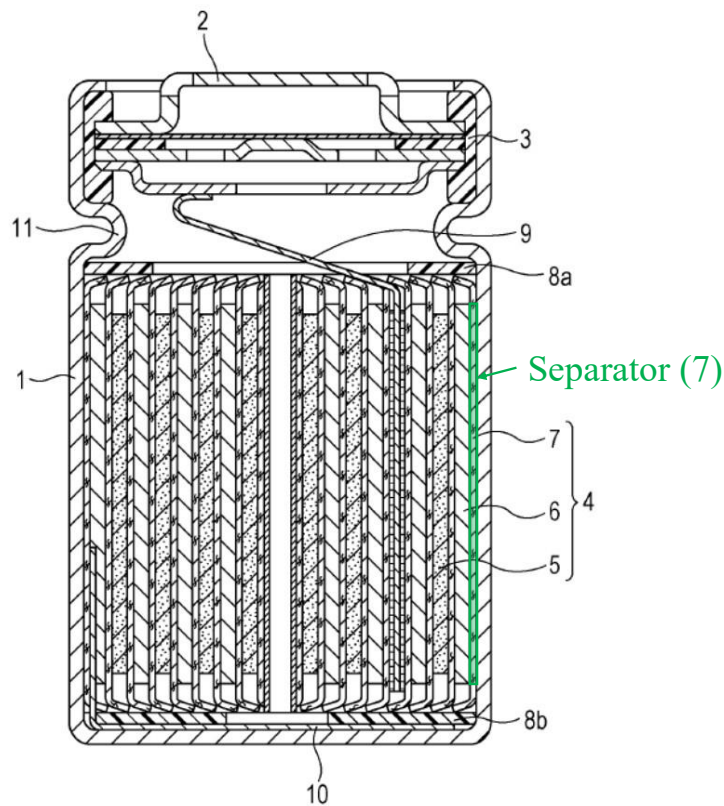
EX1005, Fig. 1*

127. Manabe discloses its electrochemical apparatus includes both a “positive electrode 5 and a long negative electrode 6” which are wound together. EX1005, ¶[0023]. Manabe discloses additional details regarding its positive electrode, such as the components, materials, dimensions, etc. *Id.*, ¶¶[0030]-[0049].

Each of Manabe's examples includes a positive electrode. *Id.*, ¶¶[0070], [0071], [0078]-[0081].

3. [10.2]: “a separator; and”

128. Manabe discloses or suggests this claim element. Specifically, Manabe discloses a *separator* (separator 7):



EX1005, Fig. 1*

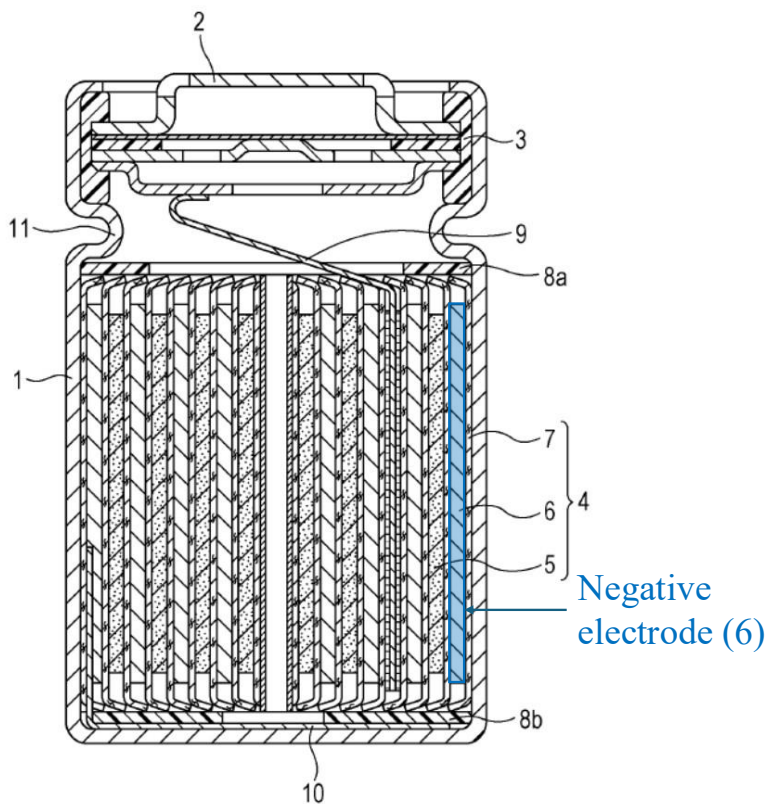
129. Manabe discloses its electrochemical apparatus includes a “separator 7” that is “interposed between” the positive and negative electrodes. EX1005,

¶[0023]. Manabe discloses examples of separators that may be used. *Id.*, ¶[0062].

Each of Manabe's examples includes a separator. *Id.*, ¶¶[0075], [0078]-[0080].¹¹

4. [10.3]: “a negative electrode; wherein the negative electrode comprises”

130. Manabe discloses or suggests this claim element. Specifically, Manabe discloses a *negative electrode* (negative electrode 6):



EX1005, Fig. 1*

¹¹ Examples 4 and 5 were prepared in the same manner as Example 3 and thus contain a separator with a length of 707.5mm. EX1005, ¶¶[0079]-[0081].

See Section VIII.B.1.

5. [10.4]: “a negative current collector;”

131. In my opinion, Manabe discloses or suggests this claim element. See Section VIII.B.2.

6. [10.5]: “a first negative active material layer, wherein the first negative active material layer is arranged on one side of a first portion of the negative current collector;”

132. In my opinion, Manabe discloses or suggests this claim element. See Section VIII.B.3.

7. [10.6]: “and a second negative active material layer, wherein the second negative active material layers are arranged on two sides of a second portion of the negative current collector, wherein the second portion of the negative current collector is different from the first portion of the negative current collector,”

133. In my opinion, Manabe discloses or suggests this claim element. See Section VIII.B.4.

8. [10.7]: “wherein a ratio of a weight per unit area of the first negative active material layer to a weight per unit area of the second negative active material layer on the negative current collector is 0.47 to 0.52,”

134. In my opinion, Manabe discloses or suggests this claim element. See Section VIII.B.5.

9. [10.8]: “and a ratio of a compacted density of the first negative active material layer to a compacted density of the second negative active material layer is 0.9 to 1.1;”

135. In my opinion, Manabe discloses or suggests this claim element. See Section VIII.B.6.

10.[10.9]: “wherein a thickness of the first negative active material layer is 40 μm to 60 μm , and a thickness of the second negative active material layer on each of the two sides of the second portion is 40 μm to 60 μm .”

136. In my opinion, Manabe discloses or suggests this claim element. See Section VIII.B.7.

J. Dependent Claim 11

1. [11.1]: “An electronic apparatus, comprising the electrochemical apparatus according to claim 10.”

137. In my opinion, Manabe discloses or suggests this claim. Specifically, Manabe discloses an *electronic apparatus* (cellphones, laptop computers, smartphones, power supplies) *comprising the electrochemical apparatus* (nonaqueous electrolyte secondary battery) *of claim 10*.

138. Manabe teaches its battery “is expected to be applied to...cellphones, laptop computers and smartphones, power supplies...for driving of BEV, PHEV and HEV, and storage-related power supplies.” EX1005, ¶[0126]. Manabe uses acronyms that a POSITA would recognize as follows: BEV is Battery Electric Vehicle, PHEV is Plug-in Hybrid Electric Vehicle, and HEV is Hybrid Electric

Vehicle. Each listed application is an electronic apparatus. Therefore, it is my opinion that Manabe discloses this element.

K. Dependent Claim 12

1. [12.1]: “The electrochemical apparatus according to claim 10, the weight per unit area of the first negative active material layer on the first portion is 65 g/m² to 130 g/m², and the weight per unit area of the second negative active material layer on the second portion is 130 g/m² to 260 g/m².”

139. In my opinion, Manabe discloses or suggests this claim. *See* Section VIII.C.1.

IX. GROUND 2: MANABE AND INABA RENDER OBVIOUS CLAIMS 5 AND 6

A. Overview of Inaba

140. Inaba discloses a non-aqueous rechargeable battery with “high capacity and favorable storage characteristics.” EX1007, ¶[0001]. Inaba states that due to requirements of increased capacity, materials including silicon and tin have been identified as alternatives to carbons materials, such as graphite. EX1007, ¶[0003]. In particular, SiO_x has been found to possess excellent loading characteristics. *Id.* But Inaba states that SiO_x suffers from “significant volume expansion and shrinkage during charge-discharge reactions.” *Id.*, ¶[0004]. Inaba cites prior art references that proposed solutions, including “limiting the utilization rate of SiO_x” in the negative electrode by creating composite particles where SiO_x (with Si being in a crystalline

state within the SiO₂) is the core of the particles and carbon covers the core. *Id.*, ¶¶[0005]-[0007].

141. Inaba's disclosed battery improves upon the prior art by optimizing the negative electrode active material layer, leading to increases in capacity and storage characteristics. EX1007, ¶[0008]. The negative electrode active material is used on a negative electrode, which is part of a non-aqueous rechargeable battery containing the negative electrode, a positive electrode, separator, and a non-aqueous electrolyte. *Id.*, ¶[0010]. The negative electrode active material further contains a graphitic carbon material. *Id.*, ¶[0010].

142. Inaba discloses that by constraining the particle size distribution of the material containing silicon and oxygen, storage characteristics of the battery are greatly improved. EX1007, ¶[0013]. Inaba specifies that particle sizes are measured using a laser scattering particle size distribution analyzer, resulting in cumulative fractions in a volume-based distribution. *Id.*, ¶¶[0009], [0019]-[0021]. Specifically, the particles should have a Dv50 of 6-10µm. *Id.*, ¶¶[0009], [0015]. If the Dv50 of the particles is below 6 µm, capacity degradation is likely to occur if the battery is stored in a charged state. *Id.*, ¶[0016]. If the Dv50 of the particles is above 10 µm, the capacity of the battery is reduced. *Id.* Further, Inaba states a Dv10 of 4 µm or greater is preferred for more favorable storage characteristics. *Id.*, ¶[0020]. A Dv90

of 14 μm or less is preferred to avoid damaging the separator and increasing battery reliability. *Id.*, ¶[0021].

143. Though the material containing silicon and oxygen can be a composite oxide of silicon with another metal, it is preferred to use silicon dispersed in an amorphous SiO_2 matrix. EX1007, ¶¶[0022]-[0023]. The material, referred to as SiO_x , is preferred to have a molar ratio of SiO_2 matrix to dispersed silicon such that x is between 0.5 and 1.5. *Id.*, ¶[0023]. Inaba further states that the silicon can be in either a microcrystalline or amorphous phase. *Id.*, ¶[0022].

144. Inaba states it is preferred for the SiO_x to form a composite with carbon material by coating the surfaces of the SiO_x particles with carbon. EX1007, ¶[0024]. This is necessary due to SiO_x 's poor conductivity. *Id.* Further, coating of the carbon material on SiO_x is preferred over simply mixing SiO_x with carbon, as coating leads to a better conductive network and therefore improved load characteristics, higher capacity, and charge-discharge cycle characteristics. *Id.*, ¶¶[0024], [0026]. Inaba teaches that the SiO_x and carbon composite particles may form larger aggregates it refers to as granules, and these granules may also include additional added carbon material. *Id.*, ¶¶[0025], [0026], [0042], [0043]. The carbon material used to coat the SiO_x is preferably "low-crystallinity carbon, carbon nanotubes, vapor-phase growth carbon fibers," or other similar materials. *Id.*, ¶[0028]. Examples of preferable carbon materials include "carbon black (including acetylene black and Ketjen

black), artificial graphite, graphitizable carbon, and non-graphitizable carbon.” *Id.*, ¶¶[0029]-[0030]. Carbon black, graphitizable carbon and non-graphitizable carbon are preferred as they have high electrical conductivity, high liquid retention, and easily maintain contact to SiO_x particles through expansion and shrinking cycles. *Id.* Inaba also teaches that graphitic carbon can be used as a negative electrode active material, and that the carbon coated composite SiO_x particles are combined with the additional carbon active material. *Id.*, ¶¶[0030], [0058].

145. Within the SiO_x carbon composite, the carbon material is between 4.7 and 33.3 mass% of the total SiO_x carbon composite, more preferably 9.1-28.6 mass%. EX1007, ¶[0035]. Note that Inaba specifies ratios of SiO_x to carbon, which have been converted into percentages in the composite.¹² Inaba discloses methods for producing both the SiO_x material and the SiO_x carbon composite. *Id.*, ¶¶[0036]-[0051].

146. Inaba discloses the use of Raman spectroscopy analysis on the SiO_x carbon composite in order to determine the ratio of intensities of the silicon peak and carbon peak. EX1007, ¶¶[0052]-[0054]. In particular, it is preferred for the ratio to be 0.25 or less to ensure that the SiO_x particle surface is sufficiently covered by carbon material, thereby improving the conductivity of the composite material. *Id.*

¹² A ratio is converted into a percentage by multiplying by 100%.

147. The structure of the negative electrode includes a current collector with a negative electrode mixture layer on one or both sides. EX1007, ¶[0056]. The negative electrode mixture layer comprises the negative active material, graphitic carbon, and a binder. *Id.*, ¶¶[0056]-[0058]. The inclusion of graphitic carbon mitigates the large volume changes experienced by SiO_x during charge and discharge cycles. *Id.*, ¶[0058]. The SiO_x carbon composite is 1-20 mass% of the total negative active materials (SiO_x carbon composite plus graphite), more preferably 3-15 mass%. *Id.*, ¶[0060]. The SiO_x carbon composite plus graphite should be between 80-99 mass% of the total negative electrode mixture layer. *Id.*, ¶[0065].

148. Inaba teaches the inclusion of binder material in the negative electrode mixture layer. EX1007, ¶[0061]. Example binders include “polyvinylidene fluoride (PVDF), polytetrafluoroethylene (PTFE), styrene-butadiene rubber (SBR), and carboxymethyl cellulose (CMC), and the like.” *Id.* The binder should be between 1-20 mass% of the negative electrode mixture layer. *Id.*, ¶[0065].

149. Inaba teaches the inclusion of additional conductive material in the negative electrode mixture layer. EX1007, ¶[0062]. The conductive material is not limited, but examples “include carbon black (thermal black, furnace black, channel black, Ketjen black, acetylene black, and the like), carbon fibers, metal powders (copper, nickel, aluminum, silver, and the like), metal fibers, and polyphenylene derivatives.” *Id.* “[C]arbon black is preferred, and Ketjen black and acetylene black

are more preferred.” *Id.* The Dv50 of the conductive material is between 0.01-10 μ m, more preferably 0.02-5 μ m. *Id.*, ¶[0063]. The conductive material should be between 1-10 mass% of the negative electrode mixture layer. *Id.*, ¶[0065].

150. Inaba teaches the negative electrode mixture layer should be 10-100 μ m thick per side of the current collector. EX1007, ¶[0065]. The density of the negative electrode mixture layer is preferably 1.0-1.9 g/cm³. *Id.*

151. The current collector is commonly copper foil, but may also be “nickel foil, a punching metal, a mesh, an expanded metal, or the like.” EX1007, ¶[0066]. The current collector is between 5-30 μ m thick in order to obtain both high energy density and mechanical strength. *Id.*

152. Inaba discloses details of the positive electrode (¶¶[0067]-[0072]), separator (¶¶[0073]-[0103], and the nonaqueous electrolyte (¶¶[0104]-[0127]). EX1007. Inaba further discloses the form of the battery is not limited. *Id.*, ¶[0128].

153. Inaba discloses experimental procedures for constructing and testing example batteries. EX1007, ¶¶[0148]-[0165]. Table 1 summarizes the composition of the example batteries, while Table 2 summarizes the test results. *Id.*, ¶¶[0165]-[0167]. The results confirm that the examples with the desired SiO_x carbon composite Dv50 have excellent storage characteristics. *Id.*, ¶[0168]. Additionally, all the examples with excellent storage characteristics had the ratio of the Raman

spectroscopy silicon peak to carbon peak below the 0.25 value taught by Inaba. *Id.*, ¶ [0167], Table 1, Table 2.

B. Dependent Claim 5

- 1. [5.1]: “The negative electrode according to claim 3, wherein a form of the silicon-based material comprises a crystalline state, an amorphous state, or a combination thereof,”**

154. Manabe does not expressly disclose the form of the silicon-based material. However, it is my opinion that a POSITA would know from their undergraduate training in materials structure that there are only two possible states of molecular (or atomic) scale order of these silicon compounds. These are “crystalline” and “amorphous.” Therefore, the silicon compounds taught by Manabe are necessarily either crystalline or amorphous because there are no other options. Therefore, it is my opinion that Manabe inherently discloses this claim element.

155. To the extent Patent Owner argues express disclosure is needed, Inaba expressly discloses that silicon oxide may be in crystalline or amorphous state, or a combination thereof and further provides motivation for a POSITA to modify Manabe’s silicon oxide material to be in Inaba’s preferred structure of having a fine Si phase dispersed in an amorphous SiO₂ matrix.

a. Inaba discloses element [5.1]

156. In my opinion, Inaba discloses or suggests this element. Specifically, Inaba discloses *the form of the silicon-based material* (composite of silicon and

silicon oxide, SiO_x) *comprises a crystalline state* (crystalline state or microcrystalline), *an amorphous state* (amorphous), *or a combination thereof*.

157. Inaba discloses a non-aqueous rechargeable battery, and in particular is directed towards the negative electrode active material for constructing the battery. EX1007, ¶¶[0001], [0008]-[0011]. The negative electrode active material contains “Si and O as constituent elements.” *Id.*, ¶[0022]. As stated above, there are only two possible states of molecular (or atomic) scale order of these silicon compounds: “crystalline” and “amorphous.” Therefore, the silicon compounds taught by Inaba are necessarily either crystalline or amorphous.

158. Beyond this inherent disclosure, Inaba teaches that the structure of the silicon compounds is preferably an amorphous matrix of silicon oxide (SiO_2) in which are dispersed smaller particles of silicon (Si), and these silicon particles may be “microcrystalline or amorphous phases.” EX1007, ¶¶[0022], [0023]. “Microcrystalline” phases of silicon are simply particles or regions of crystalline silicon that happen to be small. This is consistent with the “crystalline state” for the silicon-based material in claim [5.1] of the '082 Patent. Accordingly, Inaba discloses that silicon oxide, as used in a negative electrode active material, can be in a crystalline state in addition to an amorphous state, and that crystalline and amorphous phases of Si and SiO_2 coexist within the same particles.

b. Rationale to combine Manabe and Inaba

159. In my opinion, a POSITA would have been motivated, with a reasonable expectation of success, to modify—if necessary—Manabe’s silicon based material to be in the preferred structure taught by Inaba – “a structure in which a fine Si phase is dispersed in an amorphous SiO₂ matrix” – resulting in claim element [5.1]. EX1007, ¶[0023].

i. Analogous art

160. In my opinion, Manabe and Inaba are analogous art to each other and the '082 Patent, as they all are directed to the same field of endeavor: lithium-ion batteries, and more specifically negative electrodes. *See, e.g.*, EX1001, 1:45-48; EX1005, ¶¶[0011], [0050]-[0061]; EX1007, ¶¶[0001], [0008]-[0011]. Manabe seeks to provide a lithium-ion battery exhibiting “excellent high-temperature cycle characteristics as well as having a high capacity and a high output.” EX1005, ¶¶[0010], [0012]. Inaba similarly provides a lithium-ion battery that addresses high-temperature performance issues while maintaining high capacity. EX1007, ¶[0168].

ii. Teaching, suggestion, motivation

161. In my opinion, Inaba teaches, suggests, and motivates a POSITA to modify—if necessary—Manabe’s silicon oxide material to be in a structure in which a fine Si phase is dispersed in an amorphous SiO₂ matrix, resulting in claim element [5.1].

162. Inaba's negative electrode active material composition "greatly improved" the storage characteristics of the battery. EX1007, ¶[0013]. Specifically, the examples of Inaba showed "excellent storage characteristics of large initial discharge capacity and high capacity retention rate" across all storage conditions, including at high temperatures (45°C for 30 days). *Id.*, ¶[0168]. In contrast, the comparative examples exhibited either "inferior storage characteristics of poor capacity retention" or "low initial discharge capacity." *Id.*, Table 2, ¶[0169]. Manabe aimed to provide a battery with "excellent high-temperature cycle characteristics" as well as "high capacity." EX1005, ¶¶[0010], [0012]. While Manabe teaches the use of silicon oxide as a negative electrode active material, it does not teach a specific material structure that is preferred. Therefore, due to the above stated benefits of Inaba's negative electrode active material, a POSITA would have been motivated to incorporate the preferred structure taught by Inaba into Manabe.

**iii. Use of Known Technique to Improve
Similar Devices in the Same Way**

163. In my opinion, a POSITA would have improved—if necessary—Manabe's negative electrode by dispersing the silicon in an amorphous SiO₂ as taught by Inaba in order to enjoy the benefits of Inaba's improve negative electrode.

164. **Base device (Manabe's negative electrode):** As detailed above, Manabe discloses a negative electrode embodying claim element [5.1] except that

Manabe does not explicitly disclose that the silicon oxide material is in either a crystalline state, amorphous state, or a combination of the two. *See* Section VIII.D. Although a POSITA knows that Manabe's silicon material must inherently be either crystalline or amorphous or a combination of the two, Manabe is silent on the physical state of its disclosed silicon oxide material.

165. **Comparable device (Inaba's negative electrode):** Inaba discloses a negative electrode containing silicon oxide as an active material, and that the silicon oxide may have microcrystalline or amorphous phases of silicon. EX1007, ¶[0022]. Further, Inaba teaches that it is "particularly preferable" that the silicon is "dispersed within an amorphous SiO₂ matrix." *Id.*, ¶[0023]. By using an amorphous SiO₂ matrix, the negative active material is more predictable, stabler, has a better life cycle, and is more compatible with the graphite material. Through this phase structure, in combination with Inaba's other teachings, the negative electrode improves the capacity and storage characteristics of the battery. *Id.*, ¶[0001]. Thus, a POSITA would have been motivated to improve the negative electrode of Manabe (with an undefined silicon composite oxide (SiO_x) phase structure) by using an amorphous SiO₂ matrix as taught by Inaba, to the extent Manabe does not inherently use this phase structure already.

iv. Reasonable expectation of success

166. In my opinion, a POSITA would have had a reasonable expectation of success in achieving Inaba's phase structure for silicon composite oxides (SiO_x) in the negative electrode of Manabe.

167. Inaba and Manabe both describe negative electrodes for lithium-ion batteries with highly similar compositions: a current collector coated with negative electrode active material. EX1005, ¶[0051]; EX1007, ¶[0145]. Both disclose copper foil current collectors with a thickness of 5 to 30 μm . EX1005, ¶¶[0030]¹³, [0050], [0073]; EX1007, ¶[0066].

168. Inaba and Manabe both disclose negative electrode active material comprising silicon composite oxides (SiO_x) and graphite, wherein the graphite is the majority component. EX1005, ¶[0053] (5-30 mass % silicon composite oxides, 70-95 mass % graphite); EX1007, ¶¶[0058]-[0060] (3-15 mass % silicon composite oxides, 85-97% mass % graphite). Moreover, the active material layers have overlapping thicknesses and densities. EX1005, ¶[0058] (thickness of 40 to 120 μm ; density of 1.3 to 1.9 g/cm^3); EX1007, ¶[0065] (thickness of 10 to 100 μm ; density

¹³ This is in reference to the current collector of the positive electrode, but Manabe clarifies that the same thickness range applies to the negative current collector. EX1005, ¶[0050].

of 1.0 to 1.9 g/cm³). Both disclose the use of binder materials, with specific examples including polyvinylidene fluoride (PVDF), polytetrafluoroethylene (PTFE), and styrene-butadiene rubber (SBR). EX1005, ¶¶[0044], [0057]; EX1007, ¶[0061].

169. Inaba and Manabe both disclose positive electrodes comprising lithium transition metal oxides. EX1005, ¶¶[0032]-[0033]; EX1007, ¶¶[0067]-[0068]. Both disclose separators that may be polyolefin microporous membranes. EX1005, ¶[0062]; EX1007, ¶[0073]. And both disclose electrolytes comprising lithium salt (including LiPF₆) in a solvent that may comprise ethyl acetate (EC), methyl acetate (MEC), and dimethyl carbonate (DMC). EX1005, ¶¶[0063], [0065]; EX1007, ¶[0149].

170. For these reasons, a POSITA would have recognized that Inaba and Manabe disclose highly similar batteries with highly similar negative electrodes and negative electrode active materials. Thus, to the extent that Manabe's silicon based material did not already have Inaba's phase structure, a POSITA could (and would) have reasonably expected Inaba's silicon compound phase structure to be compatible and achievable in Manabe's negative electrode using only routine skill.

2. [5.2]: “wherein the first negative active material layer has a particle size Dv50 of 8.0 μm to 20 μm , and the second negative active material layer has a particle size Dv50 of 8.0 μm to 20 μm .”

171. Manabe does not disclose the size distribution of the particles in its negative active material layers. Inaba, however, discloses negative active material layer particle sizes falling in the claimed range and provides motivation for a POSITA to modify—to the extent required—Manabe’s particles to have the claimed particle size distribution.

a. Inaba discloses element [5.2]

172. In my opinion, Inaba discloses or suggests this element. Specifically, Inaba discloses that the *first negative active material layer* (negative electrode mixture) *and second negative active material layer* (negative electrode mixture layer) have *particle sizes Dv50 (D_{50%}) of 8.0 μm to 20 μm (15.65 μm , 15.55 μm)*.

173. Inaba discloses a NAML comprising graphite and a silicon composite oxide (SiO_x) carbon composite. EX1007, ¶¶[0014], [0022]-[0025], [0058]-[0059]. Examples 1-6 each have a NAML comprising 5 parts silicon oxide carbon composite to 95 parts graphite. *Id.*, ¶¶[0143], [0157]. The graphite has a Dv50¹⁴ of 16 μm for

¹⁴ Inaba teaches measuring the average particle size by laser diffraction and that “D_{50%}” is the “particle size at 50% of a cumulative volume-based fraction”

each example. *Id.* For Examples 1 and 3-6, the silicon oxide carbon composite has a Dv50 of 9 μm . *Id.*, Table 1. Example 2 has a silicon oxide carbon composite Dv50 of 7 μm . *Id.* The Dv50 of the NAML is therefore $15.65\mu\text{m} ((16\mu\text{m} \times 0.95) + (9\mu\text{m} \times 0.05) = 15.65\mu\text{m})$ for Examples 1 and 3-6 and $15.55\mu\text{m} ((16\mu\text{m} \times 0.95) + (7\mu\text{m} \times 0.05) = 15.55\mu\text{m})$ for Example 2. Thus, all Inaba Example Dv50 sizes fall within the claimed range.

174. If claim [5.2] refers solely to the particle sizes of the silicon-based material, it is my opinion that Inaba still discloses this element. Inaba teaches the silicon-based material should have a “D_{50%} of 6 to 10 μm .” EX1007, ¶[0009]. Additionally, in Inaba’s Examples 1 and 3-6, the silicon oxide carbon composite has

EX1007, ¶ [0019]. This is the same metric as the claimed Dv50: the ’082 Patent also uses “laser particle size analysis” and explains “Dv50 is referred to as the particle size and represents a particle size when a volume of a sample reaches 50% of a total volume from a small particle size in a volume-based particle size distribution.” EX1001, 9:35-48. Note that for Dv50, it is irrelevant whether it is defined “from a small particle size” or from the large particle size as it is the median. Thus, D_{50%} as used by Inaba corresponds to Dv50 as used in claim [5.2].

a $D_{50\%}$ of 9 μm .¹⁵ *Id.*, Table 1. Thus, it is my opinion that Inaba discloses this element under either interpretation of claim element [5.2].

b. Rationale to combine Manabe and Inaba

175. It is my opinion that a POSITA would have been motivated, with a reasonable expectation of success, to modify—if necessary—the D_{v50} s of Manabe's first and second NAMLs to use the D_{v50} of Inaba's negative active material layers, resulting in claim element [5.2].

i. Analogous art

176. *See* Section IX.B.1.b.i.

ii. Teaching, suggestion, motivation

177. In my opinion, Inaba teaches, suggests, and motivates a POSITA to modify the D_{v50} of Manabe's first and second NAMLs (if necessary).

178. Inaba teaches that the D_{v50} of the silicon-based material is important to maintaining high capacity and suppressing capacity degradation when storing the battery in a charged state. EX1007, ¶[0015]. Specifically, Inaba teaches that the D_{v50} of the silicon-based material needs to be between 6 to 10 μm . *Id.* If the D_{v50}

¹⁵ As the first and second NAMLs are comprised solely of graphite and SiO_x , and the D_{v50} of both are within the claimed range, the D_{v50} of the NAMLs in Examples 1, 3-6 must also be within the claimed range.

is below that range, “capacity degradation is likely to occur” during charged storage. *Id.*, ¶[0016]. If the Dv50 is above that range, the “center of negative electrode active material particles becomes less likely to participate in a charge-discharge reaction” causing reduced capacity. *Id.* Inaba’s test results confirm this. Examples 1-6, all of which have silicon-based material Dv50’s within Inaba’s prescribed range, exhibit “excellent storage characteristics.” *Id.*, ¶[0168], Tables 1-2. In contrast, Comparative Example 1—with a Dv50 of 5 μm —had “inferior storage characteristics.” *Id.*, ¶[0169], Tables 1-2. Similarly, Comparative Example 4—with a Dv50 of the silicon based material of 11 μm —had “low initial discharge capacity.” *Id.*, ¶[0169], Tables 1-2. As for the particle size of graphite, Inaba teaches that graphite with a Dv50 of 16 μm is compatible with the silicon-based material at the prescribed particle sizes, facilitating the “excellent storage characteristics” described above.

179. Manabe does not disclose specific particle sizes for its negative electrode mixture layer. Therefore, a POSITA would have been motivated to look to a secondary reference that teaches particle sizes for negative electrode active materials. As excellent storage characteristics and high capacity are universally desired characteristics for lithium-ion batteries, a POSITA would have been motivated to incorporate the disclosed Dv50 of Inaba’s negative electrode active material in order to obtain Inaba’s improved storage and capacity characteristics. A POSITA would further incorporate the graphite Dv50 of Inaba as Manabe fails to

teach a specific particle size distribution and a POSITA would know that graphite of the particle size disclosed by Inaba would be compatible with particles of the negative electrode mixture layer of the size taught by Inaba.

iii. Use of Known Technique to Improve Similar Devices in the Same Way

180. In my opinion, a POSITA would have improved—if necessary—Manabe’s negative electrode by using the silicon oxide particle sizes taught by Inaba in order to enjoy the benefits of Inaba’s improved negative electrode.

181. **Base device (Manabe’s negative electrode):** As detailed above, Manabe discloses claim element [5.2] except that Manabe does not explicitly disclose the particle size distribution of its silicon oxide material. *See* Section VIII.D. Thus, Manabe leaves it open as to the particle size distribution—including the Dv50—of its silicon oxide material.

182. **Comparable device (Inaba’s negative electrode):** Inaba teaches that the Dv50 of the negative electrode active materials is important to maintaining high capacity and suppressing capacity degradation when storing the battery in a charged state. EX1007, ¶[0015]. Specifically, Inaba teaches that the Dv50 of the negative electrode active material needs to be between 6 to 10 μm . *Id.* If the Dv50 is below that range, “capacity degradation is likely to occur” during charged storage. *Id.*, ¶[0016]. If the Dv50 is above that range, the “negative electrode active material

particles becomes less likely to participate in a charge-discharge reaction” causing reduced capacity. *Id.* Inaba’s test results confirm this. Examples 1-6, all of which have negative electrode active material Dv50’s within Inaba’s prescribed range, exhibit “excellent storage characteristics.” *Id.*, ¶[0168], Tables 1-2. In contrast, Comparative Example 1—with a Dv50 of 5 μm —had “inferior storage characteristics.” *Id.*, ¶[0169], Tables 1-2. Similarly, Comparative Example 4—with a Dv50 of 11 μm —had “low initial discharge capacity.” *Id.*, ¶[0169], Tables 1-2.

183. Thus, it is my opinion that a POSITA would have been motivated to improve the negative electrode of Manabe (with an undefined particle size distribution) with the particle sizes taught by Inaba in order to achieve the known improvements to capacity and storage characteristics. I note that while Inaba teaches particle sizes of the silicon compounds that overlap the claimed range, they tend toward the lower end of the claimed range. However, Inaba teaches graphite particles which are somewhat larger, and therefore the combined active material particle size taught by Inaba is squarely in the claimed range.

iv. Reasonable expectation of success

184. In my opinion, a POSITA would have had a reasonable expectation of success in modifying Manabe’s negative active material particles to have the same particle size distribution as taught by Inaba for the same reasons stated above.
Section IX.B.1.b.iv.

C. Dependent Claim 6

- 1. [6.1]: “The negative electrode according to claim 3, wherein for the silicon-based material, a ratio of a peak height at a wavenumber of $500\text{ cm}^{-1} \pm 10\text{ cm}^{-1}$ to a peak height at a wavenumber of $1350\text{ cm}^{-1} \pm 10\text{ cm}^{-1}$ in a Raman spectrum is greater than 0.”**

185. Manabe does not expressly disclose the ratio of peak heights in a Raman spectrum for the silicon-based material. Inaba, however, discloses the ratio claimed in dependent claim 6 and provides motivation for a POSITA to configure Manabe’s silicon-based material to have the claimed ratio of peak heights.

a. Inaba discloses Element [6.1]

186. In my opinion, Inaba discloses or suggests this Element. Specifically, Inaba discloses *the silicon-based material* (composite of SiO_x and carbon material) has *a ratio of a peak height at a wavenumber of $500\text{ cm}^{-1} \pm 10\text{ cm}^{-1}$ (I_{510} , Si peak, peak at 510 cm^{-1}) to a peak height at a wavenumber of $1350\text{ cm}^{-1} \pm 10\text{ cm}^{-1}$ (I_{1343} , carbon peak, peak at 1343 cm^{-1}) in a Raman spectrum (Raman spectrum) is greater than 0 (0.25 or less).*

187. Inaba teaches obtaining a “Raman spectrum” via Raman spectroscopy analysis for the silicon oxide and carbon composite material. EX1007, ¶[0052]. The intensity of the peak at 510 cm^{-1} is the silicon peak (I_{510}), while the intensity of the peak at 1343 cm^{-1} is the carbon peak (I_{1343}). *Id.*, ¶¶[0052]-[0053]. Inaba teaches that it is preferable that the ratio of I_{510}/I_{1343} is 0.25 or less. *Id.*, ¶[0052]. When within this

range, the portions where the silicon oxide particle surface is exposed is small, and therefore the effect of the carbon on improving conductivity is “more remarkably exhibited.” *Id.*, ¶[0054]. A POSITA would have understood the ratio I_{510}/I_{1343} would be greater than zero, as a ratio of zero would mean that there is no silicon exposed or near the surface of the composite particle or the particle surface is completely covered with a layer of carbon thick enough to block any Raman signal from underlying silicon. As Inaba’s negative electrode active material contains silicon (and a finite amount of carbon), it would necessarily have a I_{510} greater than zero. Therefore, it is my opinion that Inaba discloses or suggests this claim.

b. Rationale to combine Manabe and Inaba

188. In my opinion, a POSITA would have been motivated, with a reasonable expectation of success, to modify—if necessary—to modify Manabe’s negative electrode active layer such that it exhibited the peak height ratios taught by Inaba, resulting in claim 6.

i. Analogous art

189. *See* Section IX.B.1.b.i.

ii. Teaching, suggestion, motivation

190. In my opinion, Inaba teaches, suggests, and motivates a POSITA to configure Manabe’s negative electrode active layer to have the claimed ratio of Raman spectroscopy peak heights as taught by Inaba.

191. While Manabe discloses coating the surface of its silicon oxide material with carbon (Section VIII.F.1), it does not disclose further details regarding the carbon coating, much less the ratio of the intensities of the silicon peak to the carbon peak in Raman spectroscopy. Therefore, a POSITA would have been motivated to look to a second reference for more information on the coating of silicon oxide with carbon.

192. Inaba teaches in greater detail the coating of silicon oxide with carbon. EX1007, ¶¶[0042]-[0051]. More specifically, Inaba teaches that it is preferable that the ratio of intensities, in Raman spectroscopy, of the silicon peak to carbon peak be 0.25 or less. *Id.*, ¶[0052]. At this ratio, “the effect of improving conductivity due to compositing SiO_x with carbon material is more remarkably exhibited.” *Id.*, ¶[0054]. Inaba further teaches that in order to obtain the desired intensity ratio (i.e., sufficient carbon coating of the silicon oxide), the preparation conditions can be adjusted. *Id.* For example, “treatment temperature, treatment time, concentration of the liquid source of the carbon material in the treatment environment, and the like” can be adjusted to obtain the intensity ratio taught by Inaba. *Id.*

193. Manabe coats the surface of SiO_x with carbon in order to improve conductivity. EX1005, ¶[0055]. Inaba’s disclosed intensity ratio ensures that the “improv[ed] conductivity due to compositing SiO_x with carbon material is more remarkably exhibited.” EX1007, ¶[0054]. Therefore, a POSITA would have

implemented Inaba's intensity ratio, in Raman spectroscopy, of silicon peak to carbon peak in order to improve the conductivity of Manabe's negative electrode mixture layer.

iii. Use of Known Technique to Improve Similar Devices in the Same Way

194. In my opinion, a POSITA would have improved—if necessary—Manabe's negative electrode in the manner taught by Inaba in order to improve the conductivity of Manabe's anode.

195. **Base device (Manabe's negative electrode):** As detailed above, Manabe discloses a negative electrode embodying claim element [6.1] except that Manabe does not explicitly disclose the peak height ratios, in Raman spectroscopy, of its carbon coated silicon oxide material. *See* Section VIII.D. Thus, Manabe leaves it open as to the specifics of the carbon coating on the silicon oxide material.

196. **Comparable device (Inaba's negative electrode):** Inaba teaches that in a Raman spectrum, the peak at 510 cm^{-1} is the silicon peak, while the peak at 1343 cm^{-1} is the carbon peak. EX1007, ¶¶[0052]-[0053]. Inaba further teaches that the ratio of peak heights or intensities of the silicon peak to carbon peak is indicative of how thoroughly the silicon oxide material is covered by the carbon coating. *Id.*, ¶[0054]. The more thoroughly the silicon oxide material is covered by the carbon coating, the greater the improvement in conductivity of the negative electrode. *Id.*

Inaba discloses that if the ratio of peak heights or intensities of the silicon peak to carbon peak is 0.25 or less, then the carbon coating is sufficient to “remarkably exhibit[]” improved conductivity in the negative electrode. *Id.* Thus, a POSITA would have been motivated to improve the negative electrode of Manabe (with an undefined amount of carbon coating on its SiO_x material) by coating the SiO_x material with carbon sufficiently such that the ratio of intensities of the silicon peak to carbon peak is 0.25 or less as taught by Inaba.

iv. Reasonable expectation of success

197. In my opinion, a POSITA would have had a reasonable expectation of success in improving Manabe’s negative electrode by coating of the SiO_x material in the same manner as taught by Inaba. Both Inaba and Manabe coat SiO_x with carbon for use as the negative electrode active material for purposes of increasing conductivity. EX1005, ¶[0055]; EX1007, ¶¶[0026], [0054]. Moreover, Inaba and Manabe share a multitude of other similarities that would have suggested the compatibility of Inaba’s negative electrode Raman spectroscopy peak intensity ratios with Manabe’s negative electrode. *See* Section IX.B.1.b.iv. As Manabe does not specify or otherwise limit the specific implementation of the carbon coating on its SiO_x material, a POSITA would have reasonably expected Inaba’s carbon coated SiO_x material to succeed in Manabe’s negative electrode.

X. GROUND 3: MANABE AND WANG RENDER OBVIOUS CLAIM 5

A. Overview of Wang

198. Wang discloses a secondary battery comprising a positive electrode, negative electrode, electrolyte, and a separator. EX1009, Abstract, Claim 1, ¶[0006]. By matching the kinetic performance of the positive electrode and the negative electrode, Wang created a battery that “combines long cycle life, high energy density, and fast charge and discharge capability.” *Id.*, [0004]-[0005], [0012]. To create this balance, Wang coats the positive and negative electrodes with active material on one or more surfaces of the current collectors in a manner such that the following equation is satisfied: $0.1 \leq (D50_N \times M_N) / [(D50_P + 4) \times (M_P + 4)] \leq 1.5$. *Id.*, Abstract, Claim 1, ¶[0006], [0010]. $D50_N$ and $D50_P$ represent the particle size that 50% of the particles (by volume) are less than in the negative and positive active materials, respectively. *Id.*, ¶[0010]. M_N and M_P represent the capacity per unit area of the negative and positive electrode films, respectively. *Id.*

199. Wang teaches that the larger the particle size of the active material, the worse the kinetic performance of the electrode. EX1009, ¶[0013]-[0014]. And while the larger the capacity per unit area of the electrode films results in higher energy density, it conversely worsens the kinetic performance. *Id.* Therefore, Wang discovered that the equation above balances these competing factors to result in an improved battery. *Id.*, ¶[0015]. If the equation is greater than 1.5, this indicates the

positive electrode's kinetic performance is far superior to the negative electrode, which causes lithium ions to be reduced and deposited on the surface of the negative electrode. *Id.* This reduces battery performance including capacity and cycle performance. If the equation is less than 0.1, the negative electrode's kinetic performance is far superior to the kinetic performance of the positive electrode, overwhelming the positive electrode with more ions than it can accept, causing polarization, the failure to fully utilize battery capacity, and structural damage to the positive electrode active material which negatively affects the cycle life of the battery. *Id.*

200. Wang discloses that the $D50_P$ is preferably between “0.2 μm to 25 μm ,” or more preferably “0.4 μm to 15 μm ” as this results in a positive electrode with better kinetic performance and therefore improved rapid discharge capability and cycle life. EX1009, ¶[0019]. The $D50_N$ is preferably between “0.4 μm to 30 μm ,” or more preferably “0.5 μm to 16 μm ” as this results in a negative electrode with better kinetic performance and therefore improved rapid discharge capability and energy density. *Id.*, ¶[0022]. The M_P is preferably “1 mAh/cm^2 to 10 mAh/cm^2 ” or more preferably “2 mAh/cm^2 to 6 mAh/cm^2 ” as this leads to better kinetic performance, thus improving rapid discharge capability and energy density. *Id.*, ¶ [0020]. The M_N is preferably “1 mAh/cm^2 to 10 mAh/cm^2 ” or more preferably “2 mAh/cm^2 to 7

mAh/cm²” as this improves kinetic performance, leading to improved rapid discharge capability and energy density. *Id.* ¶ [0023].

201. For both the positive and negative electrodes, Wang teaches that the active material film may be coated on one or both sides of the current collector, and that the film may also include a conductive agent and a binder. EX1009, ¶¶ [0024]-[0025]. Wang discloses a variety of potential positive electrode active materials. *Id.*, ¶ [0027]. The negative electrode active material preferably “selected from one or more of carbon materials, silicon-based materials...” *Id.*, ¶ [0028]. The carbon material can be graphite, and the silicon-based material can be silicon, a silicon-oxygen compound, or a silicon-carbon composite. *Id.*

202. Wang discloses a series of experiments testing different active materials at different D50’s and different capacities per unit area. EX1009, ¶¶ [0032]-[0073]. The experiment compared the following battery performance metrics of the various experimental examples: (1) maximum charge rate; (2) discharge performance; (3) number of cycles; (4) energy density. *Id.*, ¶¶ [0058]-[0068], Table 2. The experimental results confirmed that if the equation is within the claimed range, the battery will have a long cycle life, high energy density, and rapid charge-discharge capability. *Id.*, Table 2, ¶¶ [0070]-[0073].

B. Dependent Claim 5

- 1. [5.1]: “The negative electrode according to claim 3, wherein a form of the silicon-based material comprises a crystalline state, an amorphous state, or a combination thereof,”**

203. Manabe does not expressly disclose the form of the silicon-based material. However, a POSITA knows from their undergraduate training in materials structure, that there are only two possible states of molecular (or atomic) scale order of these silicon compounds. These are “crystalline” and “amorphous.” Therefore, the silicon compounds taught by Manabe are necessarily either crystalline or amorphous because there are no other options. Therefore, Manabe inherently discloses this claim element. For this same reason (only two possible states: crystalline and amorphous), it is my opinion that Manabe renders obvious that its silicon compounds would be in the form of a crystalline state, an amorphous state, or a combination thereof.

- 2. [5.2]: “wherein the first negative active material layer has a particle size Dv50 of 8.0 μm to 20 μm, and the second negative active material layer has a particle size Dv50 of 8.0 μm to 20 μm.”**

204. Manabe does not disclose the size distribution of the particles in its negative active material layers. Wang, however, discloses negative active material layer particle sizes falling in the claimed range and provides motivation for a

POSITA to modify—to the extent required—Manabe’s particles to have the claimed particle size distribution.

a. Wang discloses element [5.2]

205. Wang discloses or suggests this element. Specifically, Wang discloses that the *first negative active material layer* (negative electrode active material) *and second negative active material layer* (negative electrode active material) have *particle sizes Dv50 (D50_{neg}) of 8.0 μm to 20 μm (20 μm)*.

206. Wang teaches the Dv50 of the negative active material is preferably “0.4 μm to 30 μm” and more preferably “0.5 μm to 16 μm.” EX1009, ¶ [0022]. These ranges improve the kinetic performance of the negative electrode, which therefore improves the rapid charge capability and cycle life of the battery. *Id.* These ranges overlap with the claimed range. Further, Wang teaches that the negative active material may be “one or more of carbon materials, silicon-based materials.” *Id.*, ¶ [0028]. The carbon material can be “graphite,” and the silicon-based material can be “silicon, silicon-oxygen compounds, [or] silicon-carbon composites.” *Id.* Thus, Wang discloses this element.

207. Example 16 of Wang discloses a negative electrode with a negative active material comprising graphite and “silicon monoxide” (i.e., silicon oxide) at an 8 to 2 ratio by mass (80% graphite, 20% silicon monoxide). EX1009, Table 1. A POSITA understands that “silicon monoxide” refers to a silicon composite oxide of

overall chemical formula, SiO_x , where $x = 1$. This is a specific example of the SiO_x , where $0.5 \leq x \leq 1.6$, which is taught by the '082 Patent. EX1001, 5:32-33, 11:23. The D50 of Example 16's negative active material is $20\mu\text{m}$. EX1009, Table 1. Thus, Wang's Example 16 Dv50 particle size is within the claimed range.

208. A POSITA would likely interpret the D50 values given in Wang's Table 1 to be referring to the negative active material, which in Wang's various examples is always a carbon material (graphite or hard carbon) and in some examples also includes silicon monoxide. A POSITA would find it clear in Table 1 that the D50 values are associated with the negative active materials identified in the adjacent (left) column.

209. To the extent that the other substances mixed with the negative active material are to be included in the particle size calculation, Wang's Example 16 still is within the claimed range. Wang discloses that the negative electrode was prepared in the same manner for all examples. EX1009, ¶ [0043]. Specifically, the negative electrode active material was mixed with "the conductive agent Super P, the thickener sodium carboxymethyl cellulose (CMC), and the binder styrene-butadiene rubber (SBR)...at a mass ratio of 94.5:1.5:1.5:2.5." *Id.*, ¶ [0036]. Super P is a specific type of carbon black that has a primary particle diameter reported to be about 27 to about 40 nm and these primary particles stick together to form aggregate particles which for Super P have an average size (diameter) of about 190 nm (0.19

μm) or 200 nm (0.2 μm). EX1014; EX1015. It is the Super P aggregate particle size that is measured by laser diffraction, and a POSITA would understand should be compared to the '082 Patent claims.

210. Styrene-butadiene rubber (SBR) used as a binder in lithium-ion batteries is generally a latex, meaning it is comprised of particles of polymer. These latex particles have sizes in the range of about 100 to 200 nm (0.1 to 0.2 μm). I cite two specific examples of commercial SBR latex particles with diameters of 140 nm and 180nm. EX1016; EX1017. Sodium carboxymethyl cellulose (CMC) is dissolved at a molecular level in battery electrode slurries, and it is not in a particulate form during processing or in the final electrode structure. *Id.* It is, in fact, the molecular level dispersion of CMC that makes it an effective viscosity modifier, i.e., thickener. Therefore, CMC does not contribute any particle size to the layer average.

211. The following table summarizes the particle sizes and composition of the components in the negative electrode layer of Wang's Example 16. For the Super P and SBR components the sizes are for the specific examples cited above. The final column of the table gives the percentage of each type of particle in the layer, which is slightly different from the ratios (or percentages) in the overall layer composition because CMC does not contribute particles to the layer, and thus does not contribute to a calculation of average particle size. The average particle size is obtained by multiplying each particle size by its particle fraction and summing these

contributions for all the types of particles. From this calculation, a POSITA calculates that the average particle size for Wang's Example 16, when all particles in the negative electrode active material layer are considered, is 19.20 μm . I note that the exact values chosen for the SBR and Super P particles, as long as they are in a reasonable range found in commercial products, will make no meaningful difference to the result of this calculation, given the small fractions of the layer that the SBR and Super P comprise. Therefore, the size of the particles in the active material layer, including all types of particles in this layer, falls within the claim range for Wang's Example 16.

Component	Particle Size (μm)	Total Ratio	Particle Fraction (%)
Active Material	20	94.5	95.94%
Super P	0.19	1.5	1.52%
CMC	Not applicable	1.5	Not applicable
SBR	0.18	2.5	2.54%

b. Rationale to combine Manabe and Wang

212. A POSITA would have been motivated, with a reasonable expectation of success, to modify—if necessary—the Dv50 of Manabe's first and second NAMLs to use the Dv50 of Wang's Example 16, resulting in claim element [5.2].

i. Analogous art

213. Manabe and Wang are analogous art to each other and the '082 Patent, as they all are directed to the same field of endeavor: lithium-ion batteries, and more specifically include details on negative electrodes. *See, e.g.*, EX1001, 1:45-48;

EX1005, ¶¶[0011], [0050]-[0061]; EX1009, ¶¶[0001], [0021]-[0022], [0025], [0028].

ii. Teaching, suggestion, motivation

214. Wang teaches, suggests, and motivates a POSITA to modify the Dv50 of Manabe's first and second NAMLs (if necessary).

215. Wang teaches that the Dv50 of the negative electrode active material is important in optimizing the kinetic performance of the negative electrode. EX1009, ¶¶ [0014], [0022]. If the Dv50 is too large, "the poorer the kinetic performance of the negative electrode plate generally is under the same conditions." *Id.*, ¶ [0014]. But if the Dv50 is within the range of "0.4 μm to 30 μm " or "more preferably...0.5 μm to 16 μm " the negative electrode has "better kinetic performance, which is more conducive to improving the fast charge capability and cycle life of the secondary battery." *Id.*, ¶ [0022]. More specifically, Example 16 of Wang demonstrated that a Dv50 of 20 μm (or in the range of 19.19 to 19.20 μm) produced a battery with excellent charge and discharge performance, plus acceptably good cycle performance. EX1009, Table 2.

216. Manabe does not disclose specific particle sizes for its negative electrode mixture layer.¹⁶ Therefore, a POSITA would have been motivated to look

¹⁶ Manabe's NAMLs do not require other components besides the negative

to a secondary reference that teaches particle sizes for negative electrode active materials. As excellent charge and discharge performance and increased cycle life are universally desired characteristics for lithium-ion batteries, a POSITA would have been motivated to incorporate the disclosed Dv50 of Wang's Example 16 negative electrode active material in order to obtain those improved characteristics.

iii. Use of Known Technique to Improve Similar Devices in the Same Way

217. A POSITA would have improved—if necessary—Manabe's negative electrode by using the negative active material particle sizes taught by Wang in order to enjoy the benefits of Wang's improved negative electrode.

218. **Base device (Manabe's negative electrode):** As detailed above, Manabe discloses claim element [5.2] except that Manabe does not explicitly disclose the particle size of its negative active material. *See* Section VIII.D. Thus, Manabe leaves it open as to the Dv50 of its negative active material layer.

active materials of graphite and the silicon-based material. EX1005, ¶ [0051]. Thus, the Dv50 of Manabe's negative active material is the Dv50 of Manabe's NAML. And to the extent other components are added, they would not bring the Dv50 below 8.0µm.

219. **Comparable device (Wang's negative electrode):** Wang teaches the Dv50 of the negative electrode active materials is important to maintaining good kinetic performance and therefore improved rapid charge capability and cycle life. EX1009, ¶¶[0014], [0022]. Specifically, Wang teaches that the Dv50 of the negative electrode active material needs to be between 0.4 to 30 μm , and more preferably between 0.5 to 16 μm . *Id.*, ¶ [0022]. If the Dv50 is above that range, the "poorer the kinetic performance of the negative electrode plate." *Id.*, ¶ [0014]. Wang's Example 16 negative electrode utilizes graphite and silicon monoxide (same as the SiO_x taught in the '082 Patent and Manabe in the case that x is 1) as the negative active material, with a Dv50 of 20 μm . *Id.*, Table 1. Example 16 exhibited excellent charge and discharge performance, along with achieving good cycle performance of the battery. *Id.*, Table 2.

220. Thus, a POSITA would have been motivated to improve the negative electrode of Manabe (with an undefined particle size distribution) by using the particle sizes taught by Wang in order to achieve the known improvements to charging/discharging performance while maintaining acceptable cycle life.

iv. Reasonable expectation of success

221. A POSITA would have had a reasonable expectation of success in modifying Manabe's negative active material particles to have the same Dv50 as taught by Wang.

222. Wang and Manabe both describe negative electrodes for lithium-ion batteries with highly similar compositions: a current collector coated with negative electrode active material. EX1005, ¶[0051]; EX1009, ¶[0025]. Both disclose negative electrode active material comprising silicon oxide (SiO_x with x in the range taught by the '082 Patent) and graphite, wherein the graphite is the majority component. EX1005, ¶[0053] (5-30 mass % silicon oxide, 70-95 mass % graphite); EX1009, ¶[0028], Table 1 (Example 16: 20 mass % silicon oxide, 80 mass % graphite). Both disclose the use of binder materials, specifically styrene-butadiene rubber (SBR). EX1005, ¶[0044], [0057]; EX1009, ¶[0036]. Both also disclose CMC as a thickener. EX1005, ¶[0046]; EX1009, ¶[0036].

223. Wang and Manabe both disclose positive electrodes comprising lithium transition metal oxides. EX1005, ¶[0032]-[0033]; EX1009, ¶[0027], Table 1. Both disclose separators that may be polyethylene. EX1005, ¶[0062]; EX1009, ¶[0040]. And both disclose electrolytes comprising lithium salt (including LiPF_6) in a solvent. EX1005, ¶[0063], [0065]; EX1009, ¶[0038].

224. For these reasons, a POSITA would have recognized that Wang and Manabe disclose highly similar batteries with highly similar negative electrodes and negative electrode active materials. Thus, to the extent that Manabe's NAML did not already have the Dv50 taught by Wang Example 16, a POSITA could (and

would) have reasonably expected it to be compatible and achievable in Manaba's negative electrode using only routine skill.

XI. CONCLUSION

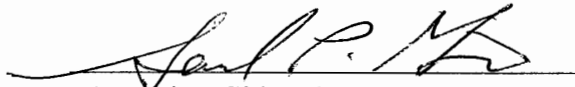
225. For these reasons, it is my opinion that the Challenged Claims of the '082 Patent are unpatentable.

226. I hereby declare that all statements made of my own knowledge are true and that all statements made on information and belief are believed to be true. I could testify to the matters in this declaration competently if called upon to do so. I further declare that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of the Title 18 of the United States Code.

Dated:

7/16/2026

By:



Samuel P. Gido, Ph.D.