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BEFORE THE PATENT TRIAL AND APPEAL BOARD

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ZHUHAI COSMX BATTERY CO., LTD.,  
Petitioner

v.

NINGDE AMPEREX TECHNOLOGY LIMITED,  
Patent Owner

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Case IPR2026-00398  
U.S. Patent No. 10,916,769

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**DECLARATION OF YU ZHU, Ph.D., IN SUPPORT OF PETITION FOR  
*INTER PARTES* REVIEW OF U.S. PATENT NO. 10,916,769**

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## **I. INTRODUCTION**

1. I have been retained as a technical expert on behalf of Zhuhai CosMX Battery Co., Ltd. (“Petitioner,” “CosMX”) to provide an analysis of U.S. Patent No. 10,916,769 (“the ’769 patent”). I understand that Petitioner is requesting that the Patent Trial and Appeal Board (“PTAB” or “Board”) institute an *inter partes* review (“IPR”) of the ’769 patent.

2. I have been asked to provide my independent analysis of the ’769 patent in light of the prior-art publications cited below.

3. I am not, and never have been, an employee of Petitioner. I received no compensation for this Declaration beyond my normal hourly compensation based on my time actually spent analyzing this patent, the prior-art publications cited below, and the issues related thereto, and I will not receive any added compensation based on the outcome of any IPR or other proceeding involving these patents.

## **II. MY PROFESSIONAL EXPERIENCE AND QUALIFICATIONS**

4. A copy of my *curriculum vitae* (“CV”) is submitted with this Declaration as Exhibit 1004. As set forth in my CV, I am a Professor in the School of Polymer Science and Polymer Engineering at The University of Akron, with expertise in polymer materials, composite and porous materials, and electrochemical energy-storage systems, including lithium-ion battery materials,

electrode architectures, and related processing and manufacturing considerations. I also serve as the Director of the Akron Functional Materials Center. I have been a member of the faculty at The University of Akron since August 2012.

5. I received my Bachelor of Science degree in Chemical Engineering from Nanjing University of Technology in 1997. I received my Ph.D. in Chemistry from the University of Cologne (Germany) in 2007. My doctoral research focused on the synthesis and characterization of conjugated polymers for electronic and electrochemical applications. My formal education provided a strong foundation in materials science, electrochemistry, polymer chemistry, and structure–property relationships directly relevant to lithium-ion battery technology.

6. After receiving my Ph.D., I worked as a Postdoctoral Research Associate at Rice University. My research at that time encompassed electrode materials, including graphene, for secondary batteries. Throughout my career, my research has focused on polymer and composite materials, porous and nanostructured materials, and coating and processing techniques relevant to electrochemical energy-storage devices. This work includes the design and characterization of materials used in lithium-ion batteries, including electrode materials, conductive and structural composites, and coatings, as well as the effects of processing conditions on material morphology and performance.

7. I have authored or co-authored more than 80 peer-reviewed journal publications in leading materials science, polymer science, and energy-storage journals. My publications address topics such as polymer and composite structure, particle and domain morphology, transport properties in functional materials, and materials strategies for improving performance, durability, and safety in electrochemical energy-storage systems

8. In addition to my scholarly publications, I am an inventor or co-inventor on U.S. and foreign patents and patent applications relating to polymer materials, composite structures, coatings, and functional materials used in energy, electronic, and electrochemical applications. These technologies involve material formulations, layered and coated structures, and manufacturing-relevant processing considerations that overlap with the cathode structures, insulating layers, and electrochemical device configurations at issue in this proceeding.

9. I am also an active member of several professional scientific organizations, including the American Chemical Society (ACS), the Electrochemical Society (ECS), the Materials Research Society (MRS), and the American Physical Society (APS). Through these organizations, I regularly engage with ongoing research developments and the state of the art in materials science and electrochemical energy-storage technologies.

10. My research routinely addresses electrode formulations, layered material architectures, coating and calendaring processes, particle-size distributions, and structure–property relationships that govern electrochemical performance and mechanical safety in lithium-ion battery electrodes. My work is directly relevant to multilayer cathode active material structures for lithium-ion batteries and processing tolerances affecting battery safety and performance, the technology underlying the '769 patent.

11. I regularly employ and interpret a broad range of materials characterization techniques relevant to polymeric and electrochemical materials, including electron microscopy, scattering and spectroscopy techniques, and thermal and mechanical characterization. I am experienced in correlating microstructural features—such as particle sizes, porosity, phase separation, coating morphology, and layer thicknesses—with electrochemical performance and safety characteristics of lithium-ion battery electrodes.

12. My work has been supported by competitive funding from government agencies and industry, including the National Science Foundation, the U.S. Department of Energy, and the American Chemical Society (ACS). I have received multiple honors and awards recognizing my contributions to materials science and polymer-based energy technologies, including an NSF CAREER Award and an Air Force Summer Faculty Fellowship.

13. Teaching is also an integral part of my professional activity. At the University of Akron, I teach undergraduate- and graduate-level courses in chemistry, polymer science, polymer materials for energy storage, and laboratory courses in polymer characterization. By teaching, mentoring, and supervising undergraduate and graduate students and postdoctoral researchers, I have maintained and continue to maintain familiarity with the level of knowledge and skill possessed by persons of ordinary skill in the art in the fields of polymer materials and lithium-ion battery technology.

14. Based on my education, research, teaching, and professional experience, I am highly familiar with the state of the art in lithium-ion battery and polymer-based energy-storage technologies as of the relevant timeframe, including conventional and multilayer cathode structures, the use of insulating layers on current collectors, processing techniques, and strategies for improving battery safety, energy density, and reliability.

15. As a result of the foregoing experience and qualifications, I am qualified to offer opinions on the technical issues addressed in this Declaration, including the understanding of a person of ordinary skill in the art and the teachings of the prior art relevant to the '769 patent.

### **III. LEGAL PRINCIPLES**

16. In forming my analysis and conclusions expressed in this Declaration, I have applied the legal principles described in the following paragraphs, which were provided to me by counsel for the Petitioner.

#### **A. Prior Art**

17. I have been informed that prior art is that which was known or used by others in the U.S., or was patented or published anywhere, before the Applicant's invention. I further have been informed that prior art includes that which was patented or published anywhere, or was in public use, on sale, or offered for sale in this country more than one year prior to the filing date of the patent application (critical date). I have also been informed that prior art includes that which was described in a U.S. patent granted on an application for a patent or in a published application for a U.S. patent that was filed by another in the U.S. before the date of invention for such a claim.

#### **B. Anticipation and Inherency**

18. I understand that a claim is anticipated if all of the limitations of the claim are disclosed in a single prior-art reference.

19. I understand that limitations may be disclosed in the prior art explicitly or inherently. That is, although a reference may not expressly disclose a claim limitation, the prior art may nonetheless anticipate the claim limitation if the prior art necessarily includes the claim limitation. Thus, an inherent disclosure is

present where the claimed structure must inevitably result from the express disclosure of the prior art. I also understand that drawings and pictures can anticipate claims so long as they clearly show the claimed structure.

20. I understand that if the prior art teaches a composition, then the properties of that composition are necessarily present. A prior-art disclosure may therefore inherently disclose a claim element reciting the properties of a composition by disclosing that composition. In other words, where a patentee claims a composition, product, or apparatus in terms of a function, property, or characteristic and the composition of the prior art is the same as that of the claim but the function is not explicitly disclosed by the reference, the reference may nonetheless anticipate the claim.

21. For that reason, the discovery of a previously unappreciated property of a prior-art composition, or of a scientific explanation for the prior art's functioning, does not render the old composition patentably new to the discoverer.

**C. Obviousness**

22. I understand that a patent claim is invalid as "obvious" in light of one or more prior-art references if it would have been obvious to a person of ordinary skill in the art at the time of the alleged invention ("POSA"), taking into account (1) the scope and content of the prior art, (2) the differences between the prior art and the claims, (3) the level of ordinary skill in the art, and (4) any so-called

“secondary considerations” of non-obviousness, which include: (i) “long felt need” for the claimed invention, (ii) commercial success attributable to the claimed invention, (iii) unexpected results of the claimed invention, and (iv) “copying” of the claimed invention by others.

23. I understand that a patent cannot be properly granted for subject matter that would have been obvious to a POSA at the time of the alleged invention, and that a patent claim directed to such obvious subject matter is invalid under 35 U.S.C. § 103. It is also my understanding that, in assessing the obviousness of claimed subject matter, one should evaluate obviousness over the prior art from the perspective of a POSA at the time the invention was made (and not from the perspective of either a layman or a genius in that art).

24. I have been informed that a claim can be obvious in light of a single prior art reference or multiple prior art references.

25. A patent can be obvious in light of a single prior-art reference if it would have been obvious to modify that reference to arrive at the patented invention. To be obvious in light of a single prior-art reference or multiple prior-art references, there must be a reason that would have prompted a POSA to modify the single prior art reference, or combine two or more references, in a manner that provides the elements of the claimed invention. This reason may come from a motivation to combine or may come from the reference(s) themselves, the

knowledge and “common sense” of a POSA, or from the nature of the problem to be solved, and this reason may be explicit or implicit from the prior art as a whole. I have been informed that, under the law, the combination of familiar elements according to known methods is likely to be obvious when it does no more than yield predictable results. I also understand it is improper to rely on hindsight in making the obviousness determination.

26. I understand that a dependent claim contains all of the limitations of the independent claim from which it depends. Thus, to establish unpatentability, every limitation set forth in a dependent claim as well as the independent claim from which it depends must be found in or be obvious from the prior art.

**D. Claim Construction**

27. I understand that, for purposes of my analysis in this *inter partes* review proceeding, the terms appearing in the patent claims should be interpreted according to their “ordinary and customary meaning.” In determining the ordinary and customary meaning, the words of a claim are first given their plain meaning that those words would have had to a POSA. I understand that the structure of the claims, the specification, and the file history also may be used to better construe a claim insofar as the plain meaning of the claims cannot be understood. I also understand that a patentee can be his own lexicographer, providing a definition for a term that otherwise does not have an established meaning in the art. Additionally,

treatises and dictionaries may be used, albeit under limited circumstances, to determine the meaning attributed by a person of ordinary skill in the art to a claim term at the time of filing. I have followed this approach in my analysis.

#### **IV. MATERIALS CONSIDERED AND BASIS OF OPINIONS**

28. My opinions are based on more than 20 years of working with polymers, composites, and materials for a wide range of applications including batteries and fuel cells, as well as my teaching and research experience. My opinions are also based on investigation and study of the relevant materials, including the patent at issue and its file history, and the prior art.

29. In the course of forming my opinions I have reviewed the following exhibits of record:

| <b>Exhibit No.</b> | <b>Description</b>                                                                   |
|--------------------|--------------------------------------------------------------------------------------|
| <b>1001</b>        | U.S. Patent No. 10,916,769                                                           |
| <b>1002</b>        | File History of U.S. Patent No. 10,916,769                                           |
| <b>1004</b>        | <i>Curriculum Vitae</i> of Yu Zhu, Ph.D.                                             |
| <b>1005</b>        | U.S. Patent Publication No. 2016/0294015 (“Tanaka”)                                  |
| <b>1006</b>        | U.S. Patent Publication No. 2015/0147624 (“Yamafuku”)                                |
| <b>1007</b>        | U.S. Patent No. 8,846,237 B2 (“Kim”)                                                 |
| <b>1008</b>        | U.S. Patent Publication No. 2016/0013480 (“Sikha”)                                   |
| <b>1009</b>        | Chinese Publication No. 202905885 with Certified English Language Translation (“Li”) |
| <b>1010</b>        | U.S. Patent Publication No. 2009/0068548 (“Kaplan”)                                  |
| <b>1011</b>        | U.S. Patent Publication No. 2011/0168550 (“Wang”)                                    |
| <b>1012</b>        | U.S. Patent Publication No. 2006/0073380 (“Kim-380”)                                 |

| <b>Exhibit No.</b> | <b>Description</b>                                 |
|--------------------|----------------------------------------------------|
| <b>1013</b>        | U.S. Patent Publication No. 2006/0088759 (“Roh”)   |
| <b>1014</b>        | U.S. Patent Publication No. 2013/0017340 (“Brown”) |

30. 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.

31. I may rely upon these materials and/or additional materials to rebut arguments raised by the Patent Owner. Further, I may also consider additional documents and information in forming any necessary opinions, including documents that may not yet have been provided to me.

32. My analysis of the materials relevant to this proceeding is ongoing and I will continue to review any new material as it is provided. This report presents only those opinions I have formed to date. I reserve the right to revise, supplement, and/or amend my opinions stated herein based on new information and on my continuing analysis of the materials already provided.

**V. DESCRIPTION OF THE RELEVANT FIELD AND A PERSON OF ORDINARY SKILL IN THE RELEVANT FIELD (ART)**

33. I have carefully reviewed the '769 patent.

34. Based on my review of these materials, I believe that the relevant field for purposes of the '769 patent is secondary battery electrode constructions and their properties.

35. In my opinion, “a person of ordinary skill in the relevant field” is a hypothetical person to whom an expert in the relevant field could assign a routine task with reasonable confidence that the task would be successfully carried out. I have been informed that evidence of the level of ordinary skill in the art can be determined based on information about the field including: the types of problems encountered, known solutions, the speed of innovation, sophistication, and the educational level of active workers. I have considered these types of information along with my own background working with students and other professionals in the field to reach my conclusion.

36. I have been advised that a person of ordinary skill in the “relevant field” (art), (i.e., a “POSA”), must be able to make and use the claimed invention based on the information disclosed in the specification of the patent. Accordingly, where information is required to make and use the claimed invention but has not been expressly disclosed in the specification, the patentee effectively acknowledges that such information should be considered to be within the knowledge of the hypothetical POSA. Whether I use the acronym POSA or not, all

of my opinions throughout this Declaration are based on the understanding of a POSA at the time of the effective filing date of the '769 patent.

37. Based on my analysis of the '769 patent, it is my opinion that a POSA at the date attributed to the invention would have had at least an undergraduate degree in chemistry, chemical engineering, polymer science and engineering, or materials science and engineering as well as two years of experience in the field of battery materials and construction. A higher level of education, such as a Master's Degree in one of these same fields, could substitute for work experience. Based on my educational background and experience, I qualify as at least a POSA at the time of the alleged invention of the patent. And, based on my experience, I have an understanding of the capabilities of a person of ordinary skill in the relevant field. I have supervised, directed, and instructed many such persons over the course of my career.

## **VI. THE DATE OF THE '769 PATENT**

38. The '769 patent was filed on March 11, 2019, and claims a priority date of November 5, 2018. For purposes of my analysis here, I have been advised by counsel to assume a date of November 5, 2018 as the date governing my analysis. I will note that an earlier or later date, by even as much as a year, would not impact the relevant analysis in this report.

## **VII. BACKGROUND OF CONVENTIONAL BATTERY TECHNOLOGY**

39. Well before the earliest filing date of the '769 patent, high-capacity electrochemical devices such as lithium-ion (“Li-ion”) batteries were widely used in consumer electronics and other applications requiring rechargeable energy storage. EX1011 (Wang), [0005]. Li-ion batteries conventionally include “an anode structure” that typically serves as the negative electrode, “a cathode structure” that typically serves as the positive electrode, “a separator layer” positioned between the anode and the cathode, and “an electrolyte” “disposed within the region between” the anode and cathode. EX1011 (Wang), [0005], [0041]. Demands for higher power and compact form factors have driven a need for higher capacity batteries capable of faster charging. EX1011 (Wang), [0009]. One well-known approach for increasing the energy density of a battery is to increase the amount of active material incorporated into the electrodes, particularly the cathode. EX1011 (Wang), [0008].

40. One established method for increasing the amount of active material in an electrode (also known as electrode loading) is to increase the amount of active material per unit electrode area, for example by forming thicker electrodes or increasing the packing density of electrode materials. EX1011 (Wang), [0008], [0051], [0092]. These approaches allow more lithium-intercalation material to be

incorporated into a single cell, directly increasing capacity without increasing the battery's external dimensions. EX1011 (Wang), [0006], [0035].

41. To achieve the above goal, multi-layer electrode—and particularly cathode—structures including layers having different power and voltage properties were a well-known technique for increasing electrode thickness, active-material content, and resulting energy density. EX1011 (Wang), [0038]. Such multi-layer cathodes are routinely formed by spraying or depositing (e.g., through roll-coating) a first slurry containing a cathodically active material onto a conductive current collector, allowing the slurry to dry, and subsequently spraying or depositing a second slurry—containing the same or a different active material—on top of the first layer. EX1011 (Wang), [0065], [0081]-[0083], [0095], [0104]-[0107]. After drying, each of the layers may be compacted or calendared to achieve a desired density or porosity. EX1011 (Wang), [0106], [0109]. This sequential deposition and compression process enables greater active material utilization, as evidenced by greater specific energy, than single-layer cathodes. EX1011 (Wang), [0130].

42. The individual layers of a multi-layer cathode can be independently tailored to achieve desired performance characteristics. For example, different layers may vary in slurry composition, porosity, active-material particle size, particle-size distribution, or packing density. EX1011 (Wang), [0035], [0056], [0079], [0083], [0086], [0101], [0107]. These design parameters were well

understood in the art to influence lithium-ion transport, electrode conductivity, mechanical strength, and overall battery performance. By selecting and combining layers with different properties, practitioners could optimize a cell for a given application.

43. In addition, a wide variety of cathode active materials were commonly used in such multi-layer structures, including lithium-transition-metal oxides such as lithium nickel-manganese-cobalt oxide (“NMC”) and related mixed-metal oxide materials, olivines such as lithium iron phosphate, and spinels such as lithium manganese oxide. EX1011 (Wang), [0006], [0043]. Anodes were typically carbon-based. EX1011 (Wang), [0007], [0044]. A broad range of particle sizes, layer thicknesses, and material densities were known and routinely selected by skilled artisans. Thus, a POSA would have been able to choose appropriate materials and layer configurations by balancing known tradeoffs among capacity, energy density, safety, manufacturability, and cost.

44. It was moreover well known long before the earliest possible filing date of the '769 patent that lithium-ion (secondary) batteries could be manufactured using either stacked (laminated) electrode assemblies or wound (jelly-roll) electrode assemblies. *See, e.g.*, EX1012 (Kim-380), EX1013 (Roh). For example, Kim-380 describes lithium secondary batteries formed using jelly-roll type electrode assemblies in which positive and negative electrode sheets and

separators are wound into a roll configuration. *See generally* EX1012 (Kim-380).

On the other hand, Roh describes, at the same time as Kim-380, stacked lithium secondary batteries formed by laminating alternating cathode and anode plates with separators. *See generally* EX1013 (Roh). By the time of the '769 patent, these alternative structures were well known alternatives that could be employed depending on the specific form factor required by the electronic device. *See* EX1005 (Tanaka), [0003]-[0004]; EX1006 (Yamafuku), [0202].

## **VIII. THE '769 PATENT**

### **A. Overview of the Claims**

45. The '769 patent is directed towards avoiding overlapping of the insulating layer with either or both of the cathode active material layers. The '769 patent achieves this by providing a “gap between the active material layer and the insulating layer.” EX1001 ('769 patent), 1:49-53, 5:16-25.

46. However, the above “gap” is not recited by any of the claims of the '769 patent. Independent claims 1, 9, and 15 do not require any “gap” between the first active material layer and the insulating layer or between the second active material layer and the insulating layer. And to the extent that a “gap” (or “distance”) is recited in some of the dependent claims (e.g., claims 2, 3, 10-13, and 16-19), each of these claims *explicitly* covers a gap of 0 mm—that is, no gap at all. For example, claims 2, 10, and 16 each recite “the first distance and the second

distance are respectively greater than *or equal to 0* and the second distance is less than *or equal to the first distance*” (emphasis added); claims 12, 13, 18, and 19 recite that zero is less than or equal to the first distance and that zero is less than or equal to the second distance. Thus, the claims of the ’769 patent do not actually reflect (or even meaningfully recite or set forth) the inventive concept as described in the ’769 patent.

47. Instead of the above feature that is central to the disclosure of the ’769 patent, the sole distinguishing feature recited in the independent claims is that a thickness of the insulating layer is greater than a thickness of the first of the two active material layers. However, as discussed in detail below, the overall layer structure of the cathode, as well as the thicknesses of the active material layers and insulating layer, were well known in the art at the time of the ’769 patent.

48. The dependent claims narrow the organization of and materials that compose the layers. Again, and as discussed further below, all of these properties were known in the art, and the prior-art contains examples of lithium-ion batteries that have such electrode structures and are made from the same materials and have the recited properties.

## **B. Prosecution History**

49. The ’769 patent issued from U.S. Patent Application No. 16/298,738 (“the ’738 application”). EX1001 (’769 patent), (21). The ’738 application was

filed on March 11, 2019 and claims priority to Chinese Patent Application No. 201811308841, filed on November 5, 2018. EX1001 ('769 patent), (22), (30).

50. During prosecution of the '769 patent, only a single Office Action was issued on June 9, 2020, in which prosecution claims 1-4, 7, and 8 were rejected under 35 U.S.C. § 102(a)(1) as being anticipated by Tanaka, and prosecution claims 5, 9-13, and 15-19 were rejected under 35 U.S.C. § 103 as being obvious over Tanaka or Tanaka in view of Yamafuku. *See* EX1002 (File history of the '769 patent), 119-31. Prosecution claims 6, 14, and 20 were determined to be allowable over Tanaka and Yamafuku. *See* EX1002 (File history of the '769 patent), 131-34. Applicant responded to the Office Action by incorporating the allowable subject matter of prosecution claim 6 into the independent claims, and the application was allowed on this basis. *See* EX1002 (File history of the '769 patent), 201, 207-09. In my opinion, none of these claims should have been allowed over Tanaka and Yamafuku.

51. For example, prosecution claim 6 recited the feature that “a thickness of the insulating layer is greater than a thickness of the first cathode active material layer,” which was subsequently incorporated into patented independent claims 1, 9, and 15. EX1002 (File history of the '769 patent), 44. However, as explained below in detail, Tanaka *inherently* discloses this relationship and, separately, *explicitly describes* a range of thicknesses for insulating member 40 that would satisfy this

claim element. *See below* § XI.A.9. Thus, it is my opinion that the Examiner erred in failing to appreciate these teachings in Tanaka.

52. In my opinion, the allowance of prosecution claim 6 is not the only error made by the Examiner during prosecution of the '769 patent. For example, the Examiner incorrectly interpreted prosecution claim 9 (issued claim 8) as requiring *both* a polymer and inorganic particles. *See* EX1002 (File history of the '769 patent), 123-24 (explaining that Tanaka discloses the claimed polypropylene polymer but relying on Yamafuku to explicitly teach the claimed inorganic particles). However, the claim actually only requires "*at least one of* inorganic particles *and* a polymer." EX1001 ('769 patent), claim 8 (emphasis added). Thus, it is my opinion that the Examiner erred by misunderstanding the scope of prosecution claim 9 and failing to reject this feature over Tanaka alone.

53. It is further my opinion that the Examiner's allowance of prosecution claims 14 and 20 (allowed claims 12 and 19) over Tanaka constitutes an error. The Examiner indicated these claims were allowable over Tanaka due to the recitation that " $0 \leq \text{the first distance} \leq \frac{\pi}{4} * D + 4 \text{ mm.}$ " File history of the '769 patent, 132-34. This feature recites, at a minimum, that the first distance falls within the range of 0 mm to 4 mm, inclusive. However, as explained below in detail, Tanaka describes that a distance between the end part of the first active material layer 2a and the end part of the second active material layer 2b (that is, the length of region

S) may be “0.5 to 3 mm,” and Figure 10 of Tanaka shows that the distance between first active material layer 2a and insulating member 40 (i.e., the claimed “first distance”) may be *even less*. EX1005 (Tanaka), [0066], FIG. 10 (showing that the “first distance” between the end of layer 2a and the closest end of insulating member 40 is less than the distance of single-layer part S). Accordingly, it is my opinion that Tanaka *explicitly discloses* exactly the feature of prosecution claims 14 and 20 that the Examiner found to be allowable.

54. In my opinion, the Examiner’s analysis of the claims of the ’769 patent and the disclosure of Tanaka contains several errors. At a minimum, a POSA would understand that prosecution claims 6, 9, 14, and 20 are disclosed by Tanaka. I believe that the Examiner’s failure to fully comprehend the scope of these claims, the teachings of Tanaka, or both, constitutes a material error.

55. Moreover, in my opinion, the Examiner, as a POSA, *should* have been aware that all of the features recited in the claims of the ’769 patent were well known in the prior art, as shown below. Thus, the Examiner also materially erred in my opinion, by failing to uncover, consider, or at least apply additional prior art that teaches the *very broad* features recited by the claims of the ’769 patent.

## **IX. OVERVIEW OF PRIOR ART**

### **A. Tanaka (U.S. Pat. Pub. No. 2016/0294015)**

56. Tanaka describes a secondary battery and a production method focused on improving safety and manufacturability by combining (i) a laminated electrode assembly and (ii) a shaped, multi-layer active material coating with an insulating member at the coated/uncoated boundary. EX1005 (Tanaka), Abstract, [0029]-[0030], [0049]-[0050]. Tanaka explains that a secondary battery “includes an electrode laminate body” having positive and negative electrodes “alternately laminated with a separator 20 interposed therebetween.” EX1005 (Tanaka), [0031]. The positive electrode (or cathode) includes a “positive electrode active material layer 2 having a multi-layer structure” of a “first active material layer 2a” formed on positive electrode current collector 3 and “second active material layer 2b” laminated on first active material layer 2a. EX1005 (Tanaka), [0035].

57. Tanaka further describes that “insulating member 40 [is] formed so as to cover border part 4 between the applied part and non-applied part of positive electrode active material layer 2.” EX1005 (Tanaka), [0048]. Although insulating member 40 is placed at this boundary region for short-circuit prevention, EX1005 (Tanaka), [0005], this leads to a local increase in “the thickness of the battery electrode assembly” and thus a decrease in “the energy density per volume.” EX1005 (Tanaka), [0008]. To address this issue, Tanaka carefully controls the

thickness of insulating member 40 to have a “thickness of 10  $\mu\text{m}$  or greater” but “smaller than the average thickness of multi-layer part M” that is composed of first active material layer 2a and second active material layer 2b. EX1005 (Tanaka), [0051]. Specifically, Tanaka instructs that the thickness of insulating member 40 should be “90% or less of the average thickness of multi-layer part M ... and more preferably [] 60% or less of the average thickness of multi-layer part M.” EX1005 (Tanaka), [0051]. This range of thicknesses for insulating member 40 ensures that “the thickness of the electrode laminate body” is sufficiently achieved. EX1005 (Tanaka), [0051].

**B. Yamafuku (U.S. Pat. Pub. No. 2015/0147624)**

58. Yamafuku describes an energy storage device (e.g., a lithium-ion secondary battery) that uses an electrode assembly made from sheet-like, belt-shaped electrodes and a separator that are assembled and then wound. EX1006 (Yamafuku), Abstract, [0074]-[0075]. Specifically, Yamafuku’s electrode assembly “includes a sheet-like positive electrode 3, a sheet-like negative electrode 5 and a sheet-like separator 4 arranged between the positive electrode 3 and the negative electrode 5.” EX1006 (Yamafuku), [0075]. The electrode assembly demonstrates improved short-circuit robustness due to laminated layers having different binder chemistries. *See* EX1006 (Yamafuku), [0042], [0044]-[0047]. Yamafuku describes that this lamination technique can be used in either a wound-

type electrode assembly or “a stacked type assembly.” EX1006 (Yamafuku), [0202].

**C. Kim (U.S. Pat. No. 8,846,237)**

59. Kim discloses an electrode assembly and secondary battery designed to improve safety and durability by addressing damage to separators caused by non-uniform electrode coating regions. EX1007 (Kim), Abstract. Kim explains that, during slurry coating of electrode plates, a “starting region” becomes thicker due to slurry accumulation, while an “ending region” becomes thinner due to a “tailing phenomenon.” EX1007 (Kim), 1:60-67. These phenomena create non-uniform coating regions that can damage a separator during winding and cause internal short circuits. EX1007 (Kim), 2:1-9.

60. To mitigate the above issue, “an insulating member [is] disposed on one side of the positive or negative electrode non-coating portion and formed adjacent to at least one of the ends of the” respective electrode coating portion. EX1007 (Kim), 2:29-41. To effectively prevent separator damage and internal short circuits, the insulating member is preferably spaced “3.5 mm or less” from the end of the electrode coating portion to effectively prevent separator damage and internal short circuits. EX1007 (Kim), 2:42-45, 6:39-52.

**D. Sikha (U.S. Pat. Pub. No. 2016/0013480)**

61. Sikha discloses multi-layer cathode active material structures designed to enable thicker, higher-capacity electrodes for lithium-ion batteries. *See* EX1008 (Sikha), [0004], [0009], [0024]. Sikha describes forming a cathode by sequentially depositing multiple cathode material layers on a conductive substrate, explaining that “a method for forming a multi-layer cathode structure” includes depositing “a first slurry mixture comprising a cathodically active material” on a current collector “to form a first cathode material layer,” and then depositing “a second slurry mixture comprising a cathodically active material ... on the first cathode material layer 210.” EX1008 (Sikha), [0034], [0035], [0038], [0053].

62. Sikha emphasizes that the individual layers may be engineered to have different properties, stating that “the multilayer electrodes have different properties (e.g., porosity, surface area, electrode composition) in each layer,” or “different active material chemistries in each layer.” EX1008 (Sikha), [0023]. Sikha also discloses that the first cathode layer may function as a dense “energy layer” by “having a high packing density” while the second, overlying cathode layer, which is more porous, may function as a “power layer.” EX1008 (Sikha), [0068]. This combination of cathode active layers is able to achieve “higher power” and “longer cycle compared to a single layer electrode having uniform properties.” EX1008 (Sikha), [0024].

**E. Li (Chinese Pat. Pub. No. 202905885U)**

63. Li discloses a prismatic lithium-ion battery having a winding structure in which the corner regions of the electrode assembly are specially configured to reduce deformation while maintaining safety, including the use of insulating or protective layers at the corners. EX1009 (Li), Title, Abstract, FIG. 3. In at least one embodiment, the corner regions of Li's positive and negative electrodes are intentionally left uncoated, such that "the corner regions of the positive electrode 1 and the negative electrode 2 are blank positive electrode current collectors, that is, no active material layer is coated." EX1009 (Li), [0035]. Applying a protective or insulating layer to the corner regions "prevent[s] the blank current collectors from puncturing the separator." EX1009 (Li), [0035].

64. Li further specifies that this protective layer may take multiple forms, including "an adhesive tape, a protective coating, or a conductive coating," and that "the thickness of the protective layer is 1-3 times that of the corresponding current collector," thereby ensuring mechanical protection and insulation of the separator in the corner portions of the wound electrode assembly. EX1009 (Li), [0035]. Li explains that this corner-region configuration reduces stress concentration and deformation in wound prismatic cells while maintaining electrical safety, with the protective layer specifically serving to avoid short

circuits caused by exposed current collectors at the electrode corners shown in Figure 3. *See* EX1009 (Li), [0017].

**F. Kaplan (U.S. Pat. Pub. No. 2009/0068548)**

65. Kaplan discloses prismatic cells for lithium-ion secondary batteries. EX1010 (Kaplan), Title, Abstract. Kaplan describes that this form factor has “desirable properties for use in digital cameras and other applications,” such as “cell phones, MP3 players, and personal digital assistants (PDA’s) such as Blackberries®.” EX1010 (Kaplan), [0005], [0007].

66. According to EX1010 (Kaplan), the thickness of the prismatic cell, relative to the length and width of the cell, is the defining structural dimension of the prismatic cell: prismatic cells “generally have a thickness that is much less than their width and length.” EX1010 (Kaplan), [0005]. For example, Kaplan identifies a commercial prismatic lithium-ion battery having “a length of about 53.0 mm, a width of about 35.2 mm, and a thickness of about 7.0 mm.” EX1010 (Kaplan), [0005]. More generally, Kaplan states that “[m]any prismatic cells have dimensions in the ranges of 40–60 mm long by 30–40 mm wide by 4–10 mm thick.” EX1010 (Kaplan), [0005]. Kaplan also defines prismatic cells as having “a thickness of between about 2 mm and about 15 mm (e.g., between about 4 mm and about 10 mm).” EX1010 (Kaplan), [0015].

67. Kaplan describes that such prismatic cells may be “fast-charge capable rechargeable cells that can provide more than 100 cycles, typically many hundreds or thousands of cycles,” making them ideal for use in portable electronic devices. EX1010 (Kaplan), [0008].

## **X. CLAIM CONSTRUCTION**

68. I understand that, during an *Inter Partes* Review, claim terms must be given their ordinary and customary meaning as understood by a POSA at the time of the invention, in light of the specification and the prosecution history of the patent. I understand that, solely for the purposes of this Petition, all claim terms should receive their plain and ordinary meaning in the context of the '769 patent specification. I further understand that, even if other terms end up being expressly construed in another proceeding, such express constructions are not necessary here, as they are not needed to resolve a controversy in this proceeding.

## **XI. GROUND 1A: CLAIMS 1-8 ARE ANTICIPATED BY TANAKA**

69. Tanaka expressly or inherently discloses all of the limitations of claims 1-8 and therefore anticipates these claims.

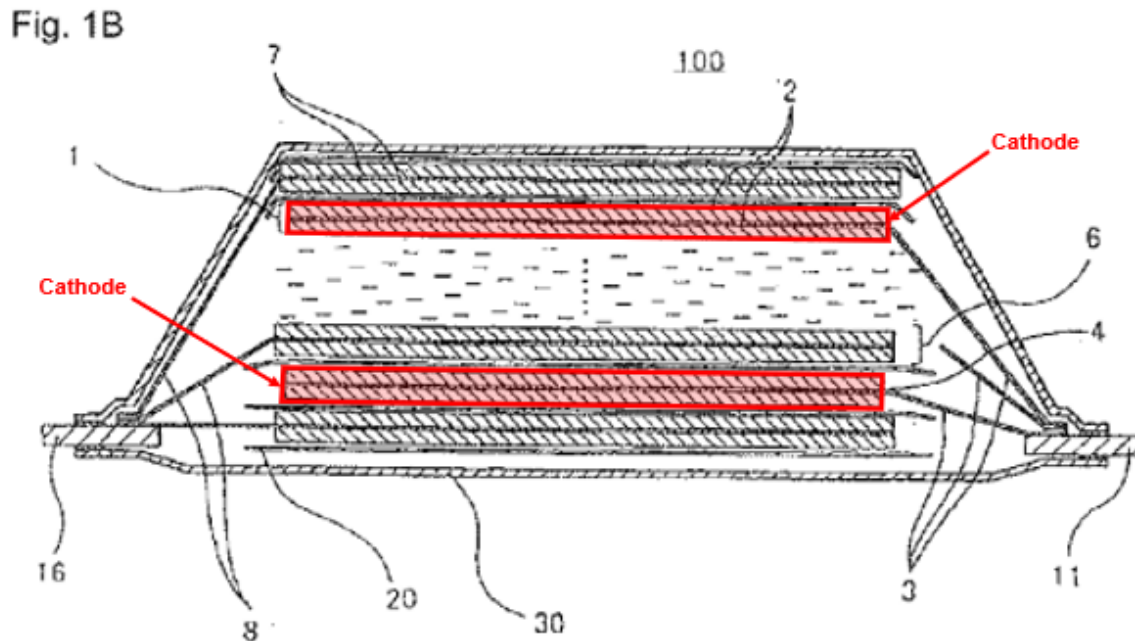
### **A. Independent Claim 1**

#### **1. 1.P: A cathode, comprising:**

70. Tanaka discloses a “positive electrode” (e.g., a “cathode”). *See* EX1005 (Tanaka), Abstract. Specifically, Tanaka discloses “an electrode laminate body (battery electrode assembly) in which positive electrodes (positive electrode

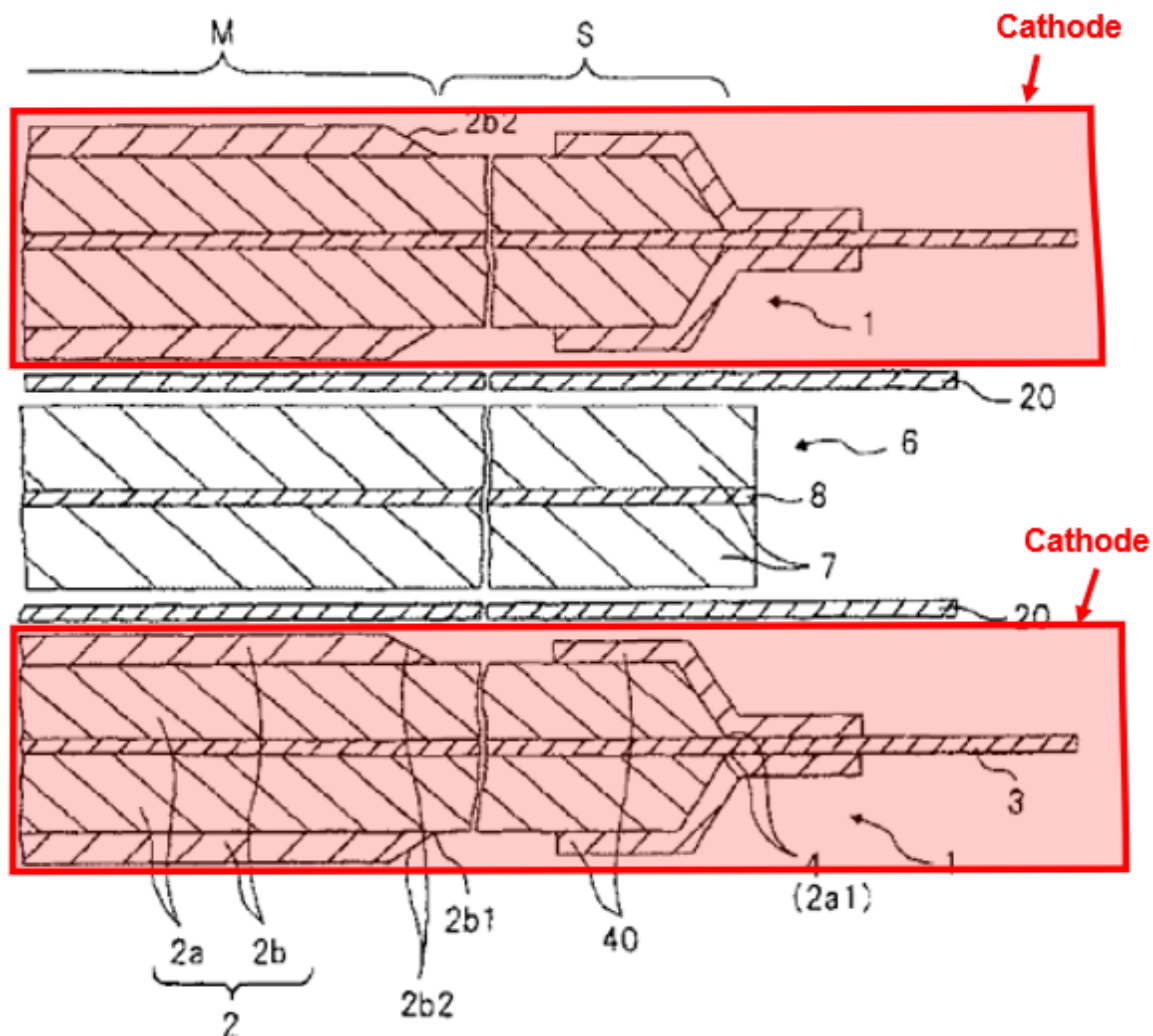
sheets) 1 and negative electrodes (negative electrode sheets) 6 are alternately laminated with separator 20 interposed therebetween such that layers are formed.”

EX1005 (Tanaka), [0031], FIG. 1B.

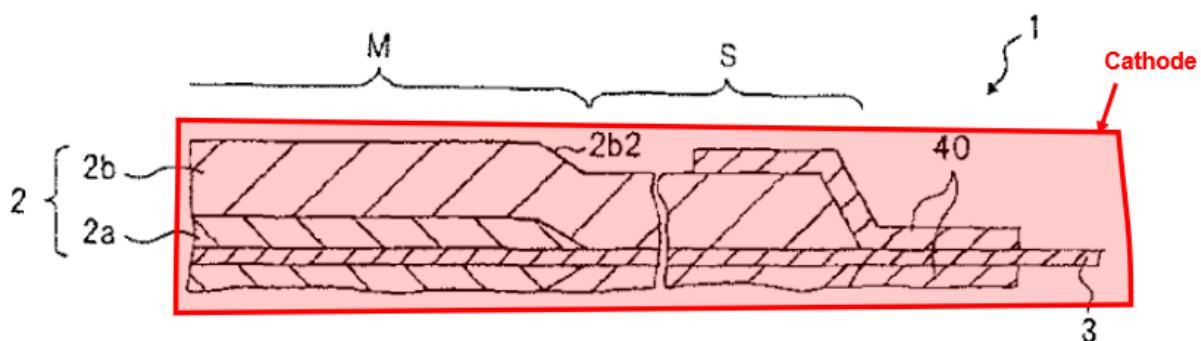


EX1005 (Tanaka), FIG. 1B (annotated).

71. Tanaka’s positive electrode “includes [a] current collector (positive electrode current collector) 3 for the positive electrode, and active material layer (positive electrode active material layer) 2 for the positive electrode applied on positive electrode current collector 3.” EX1005 (Tanaka), [0032]; *see below* EX1005 (Tanaka), FIGS. 2 and 10.



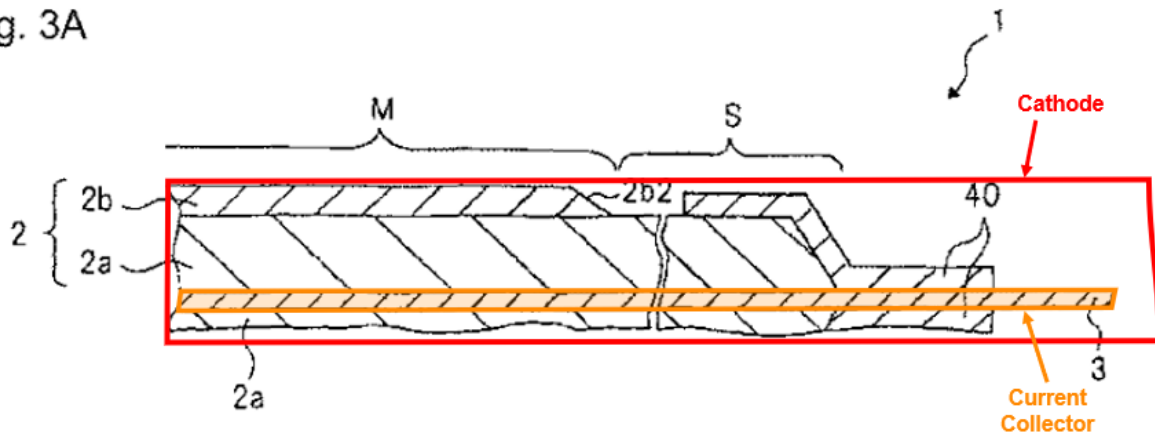
EX1005 (Tanaka), FIG. 2 (annotated).



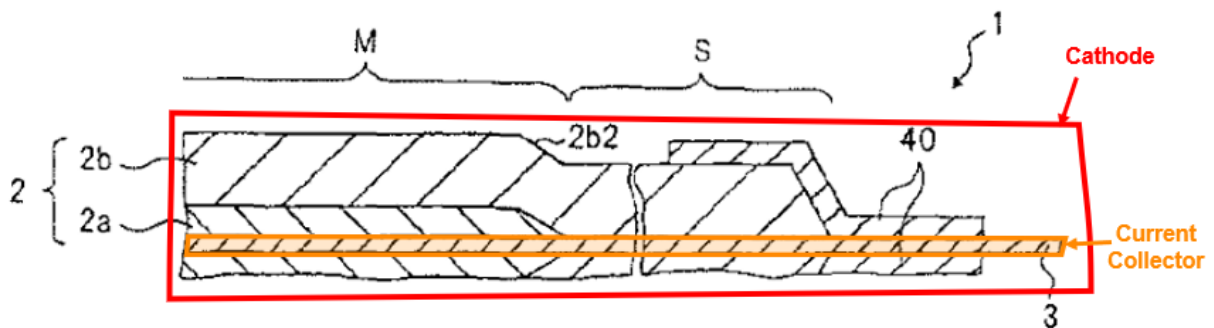
EX1005 (Tanaka), FIG. 10 (annotated).



Fig. 3A



EX1005 (Tanaka), FIG. 3A (annotated).



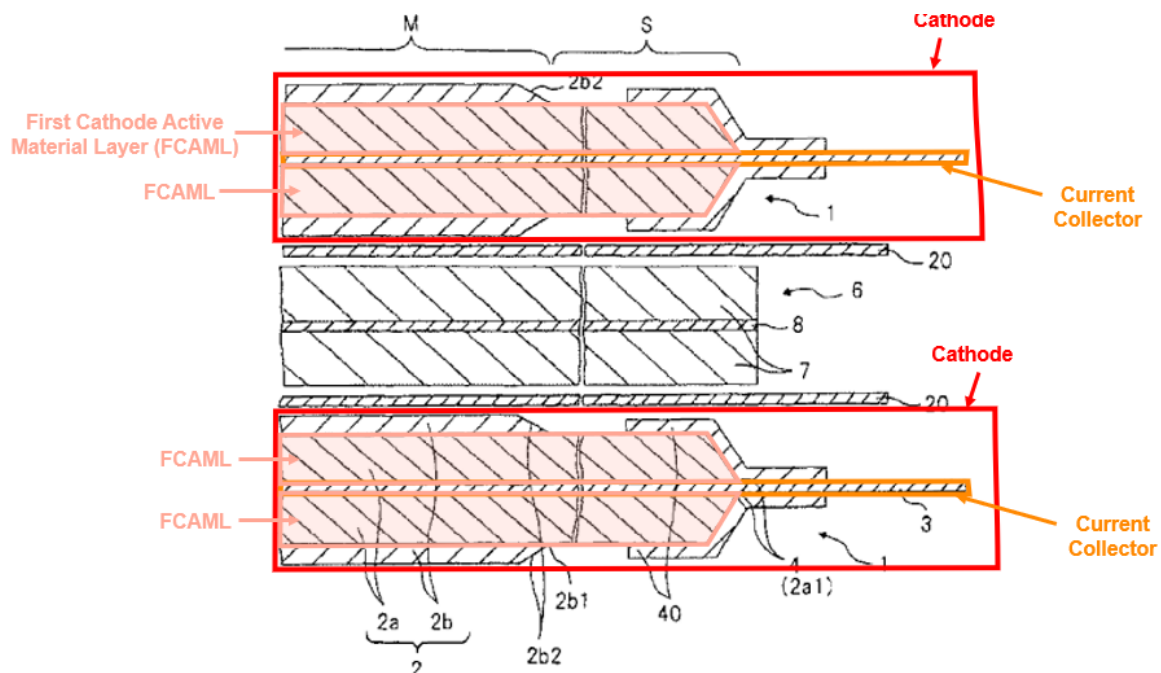
EX1005 (Tanaka), FIG. 10 (annotated).

74. Tanaka's positive electrode current collector 3 is the same cathode current collector as recited in limitation 1.A.

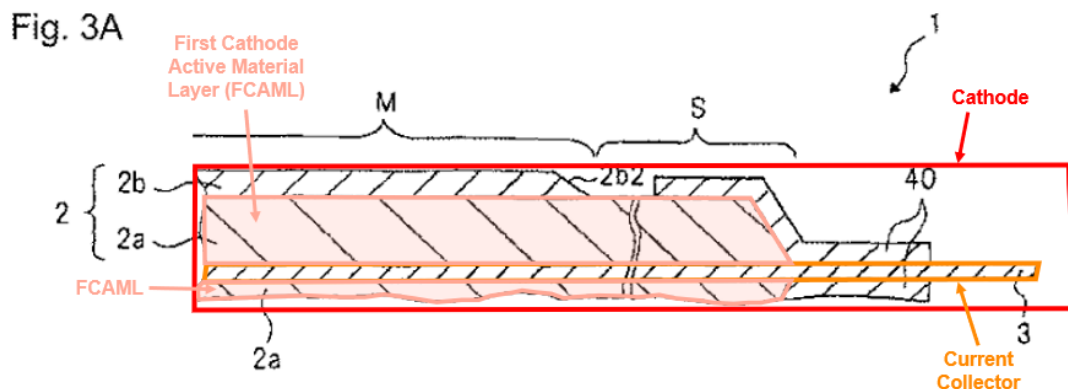
**3. 1.B: a first cathode active material layer, comprising a first cathode active material;**

75. Tanaka discloses a first active material layer 2a that is formed on an applied part of current collector 3. *See* EX1005 (Tanaka), [0012], [0035]. An “active material mixture” that includes “for example, layered, oxide-based materials such as  $\text{LiCoO}_2$ ,  $\text{LiNiO}_2$ ,  $\text{LiNi}_{(1-x)}\text{CoO}_2$ ,  $\text{LiNi}_x(\text{CoAl})_{(1-x)}\text{O}_2$ ,  $\text{Li}_2\text{MO}_3$ — $\text{LiMO}_2$  and  $\text{LiNi}_{1/3}\text{Co}_{1/3}\text{Mn}_{1/3}\text{O}_2$ , spinel materials such as  $\text{LiMn}_2\text{O}_4$ ,

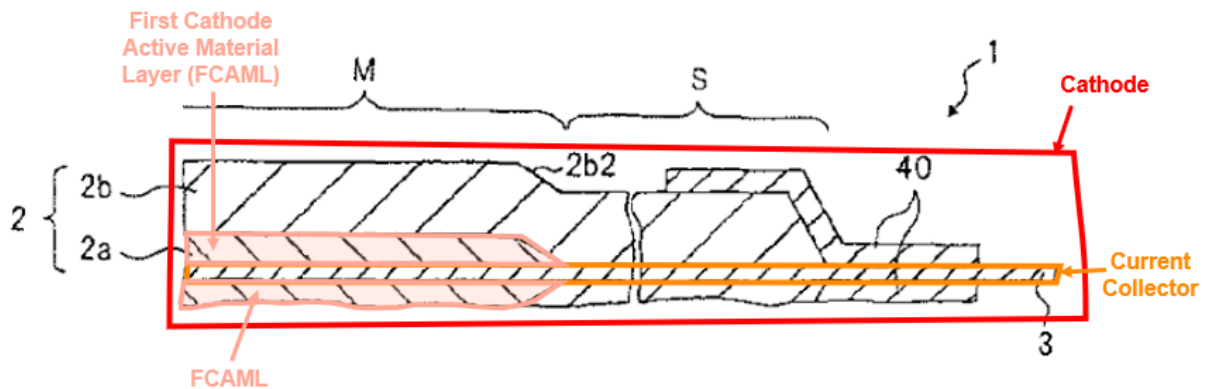
$\text{LiMn}_{1.5}\text{Ni}_{0.5}\text{O}_4$  and  $\text{LiMn}_{(2-x)}\text{M}_x\text{O}_4$ , olivine materials such as  $\text{LiMPO}_4$ , olivine fluoride materials such as  $\text{Li}_2\text{MPO}_4\text{F}$  and  $\text{Li}_2\text{MSiO}_4\text{F}$ , and vanadium oxide materials such as  $\text{V}_2\text{O}_5$  ... , and mixtures of two or more kinds of them” is “applied on positive electrode current collector 3 so that first active material layer 2a is formed.” EX1005 (Tanaka), [0035], [0040]; *below* EX1005 (Tanaka), FIGS. 2, 3A, and 10.



EX1005 (Tanaka), FIG. 2 (annotated).



EX1005 (Tanaka), FIG. 3A (annotated).

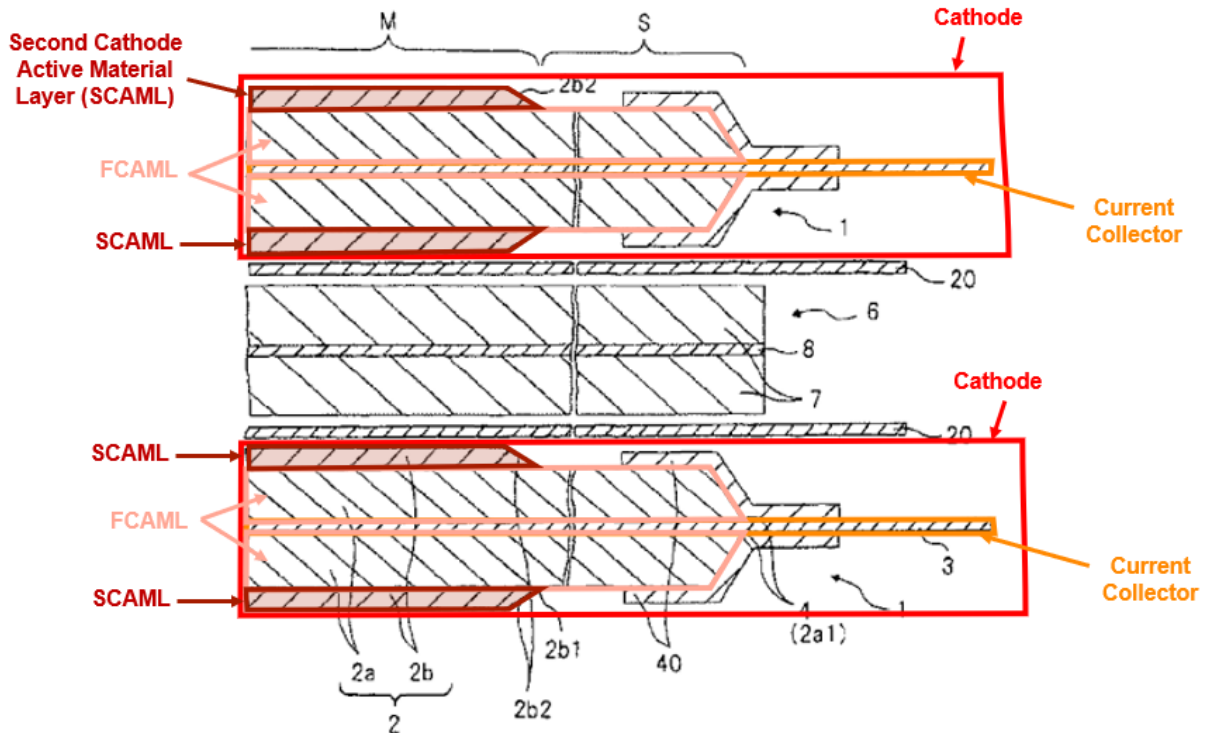


EX1005 (Tanaka), FIG. 10 (annotated).

76. Tanaka’s first active material layer 2a comprising an active material is the same first cathode active material layer comprising a first cathode active material recited in limitation 1.B.

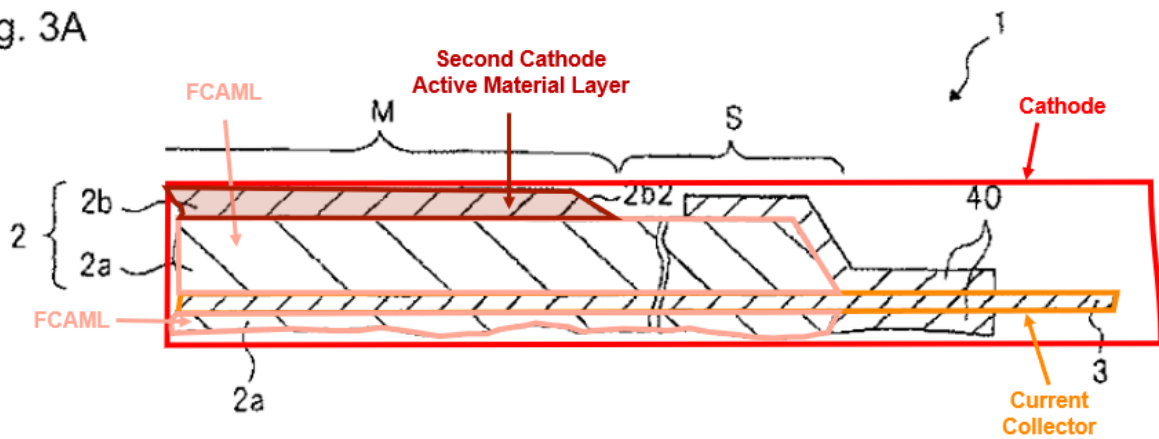
**4. 1.C: a second cathode active material layer, comprising a second cathode active material;**

77. Tanaka discloses a second active material layer 2b laminated on first active material layer 2a. *See* EX1005 (Tanaka), [0012]. Tanaka’s positive electrode “active material layer has a multi-layer structure that includes a first active material layer and a second active material layer.” EX1005 (Tanaka), [0012]. The “second active material layer 2b is laminated” on first active material layer 2a by applying “an active material mixture agent” on top of first active material layer 2a. EX1005 (Tanaka), [0035]; *see also* EX1005 (Tanaka), [0040], [0050]; *see below* EX1005 (Tanaka), FIGS. 2, 3A, 10.



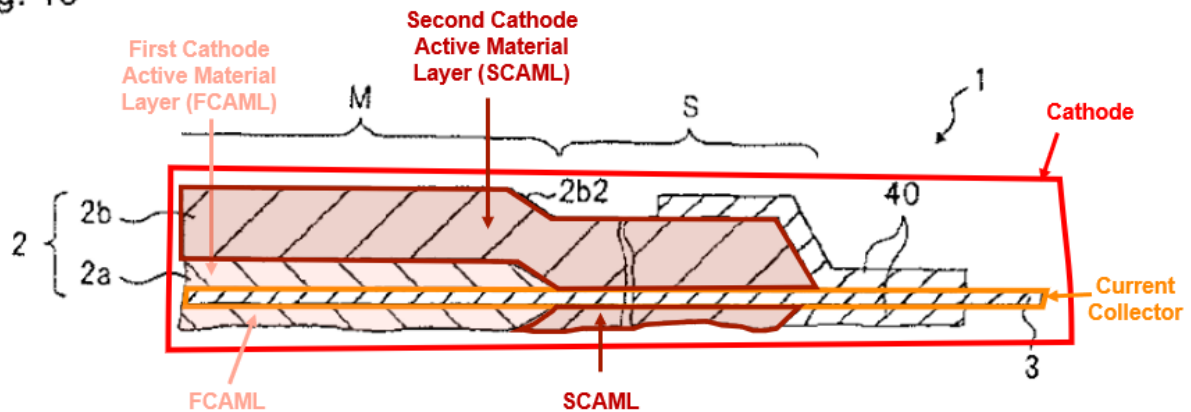
EX1005 (Tanaka), FIG. 2 (annotated).

Fig. 3A



EX1005 (Tanaka), FIG. 3A (annotated).

Fig. 10

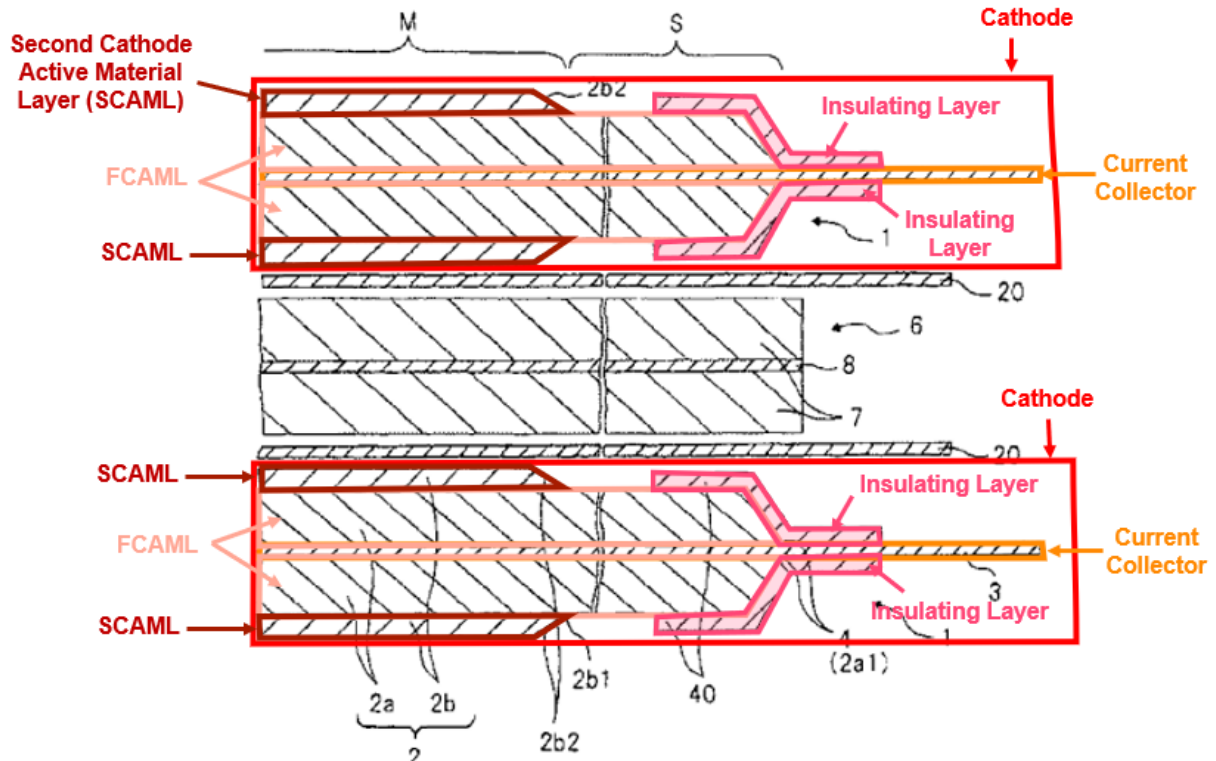


EX1005 (Tanaka), FIG. 10 (annotated).

78. Tanaka's second active material layer is the second cathode active material layer of limitation 1.C.

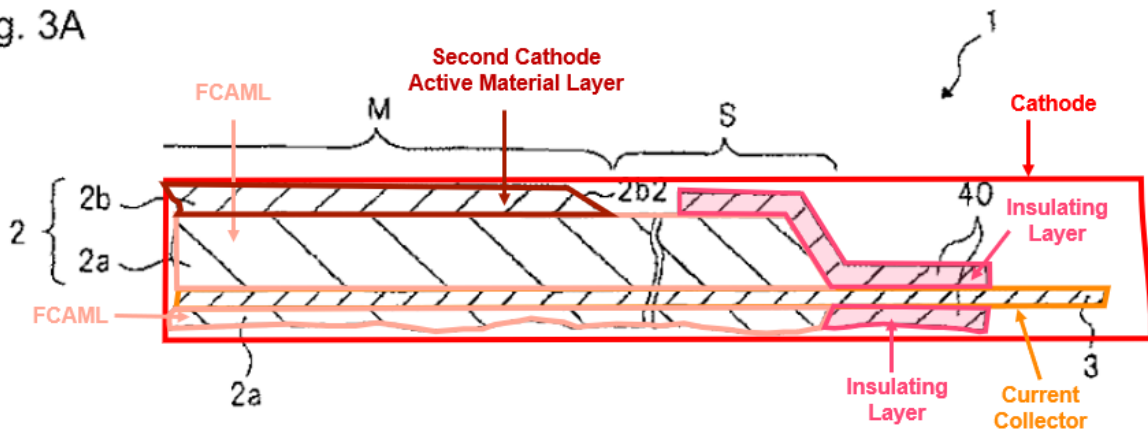
**5. 1.D: an insulating layer, wherein**

79. Tanaka discloses that “insulating member 40 is formed so as to cover border part 4 between the applied part where positive electrode active material layer 2 is formed and the non-applied part where positive electrode active material layer 2 is not formed.” EX1005 (Tanaka), [0036]; *see also* EX1005 (Tanaka), [0012], *see below* EX1005 (Tanaka), FIGS. 2, 3A, and 10. Tanaka's insulating member 40 may be made of “polyimide, glass fiber, polyester, polypropylene, or materials containing them” and “can be formed by bonding a tape-like resin member to border part 4 by heat, or by applying a gel-like resin border part 4 and then drying the resin.” EX1005 (Tanaka), [0048].



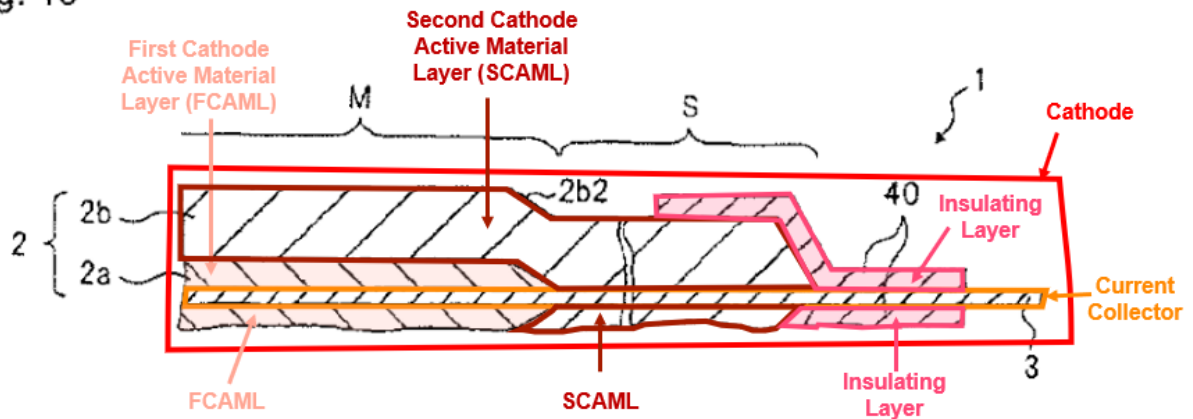
EX1005 (Tanaka), FIG. 2 (annotated).

Fig. 3A



EX1005 (Tanaka), FIG. 3A (annotated).

Fig. 10

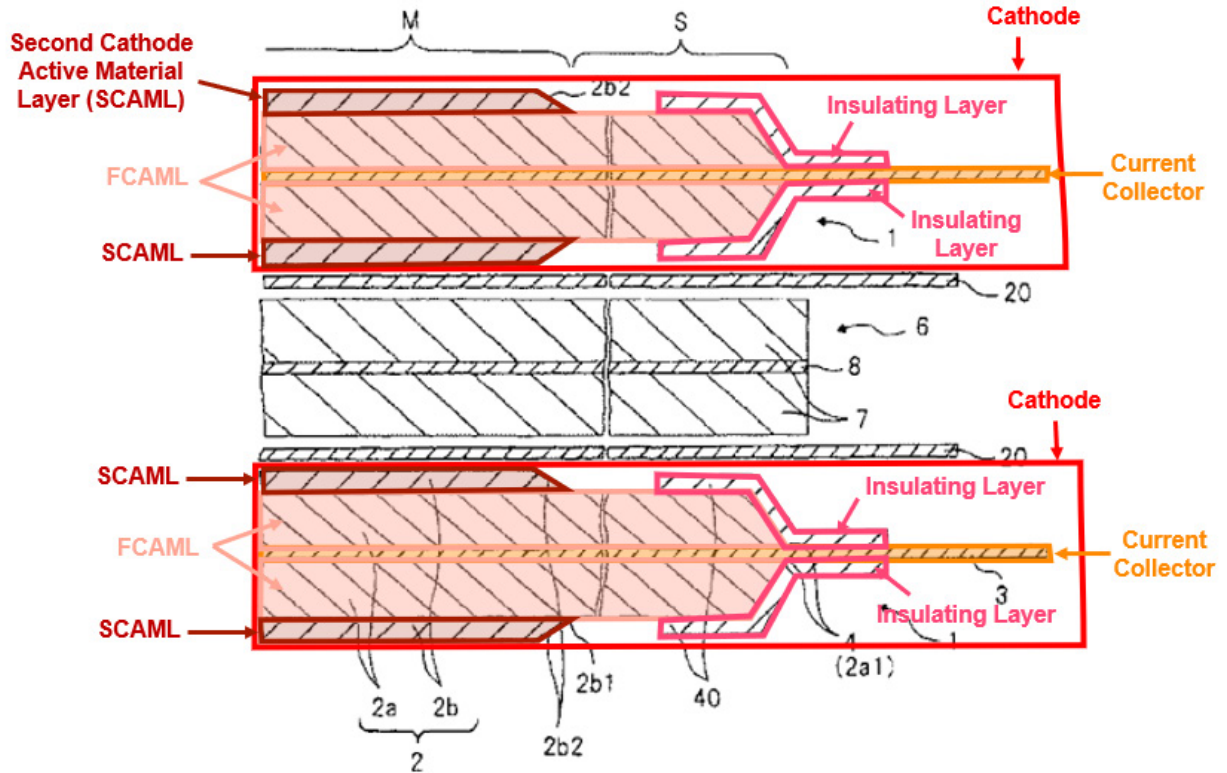


EX1005 (Tanaka), FIG. 10 (annotated).

80. Tanaka's insulating member 40 is the same as the insulating layer recited by limitation [1.D].

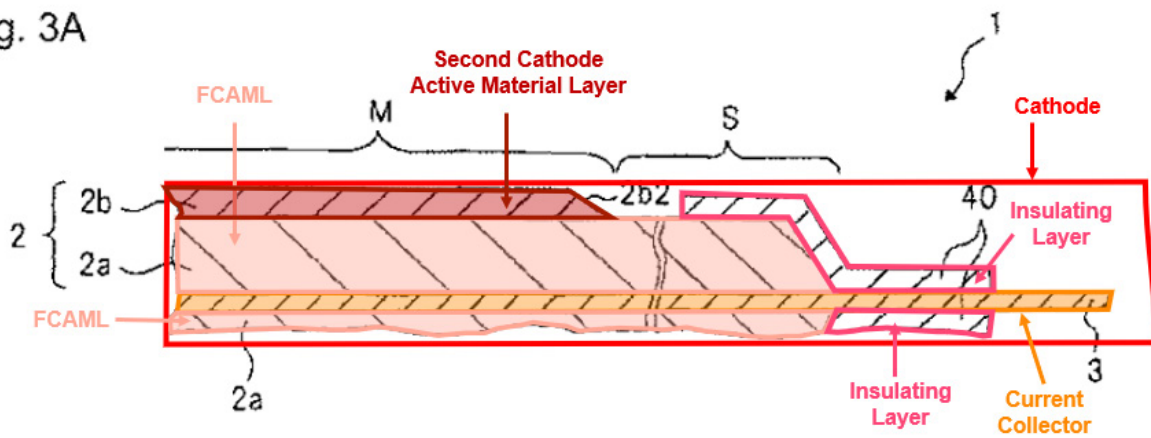
**6. 1.E.1: the first cathode active material layer is disposed between the cathode current collector and the second cathode active material layer**

81. Tanaka discloses that first active material layer 2a is disposed on current collector 3 and then second active material layer 2b is subsequently disposed on first active material layer 2a. EX1005 (Tanaka), [0012], [0035], [0050]. Thus, Tanaka's first active material layer 2a is between cathode current collector 3 and second active material layer 2b. *See below* EX1005 (Tanaka), FIGS. 2, 3A, and 10.



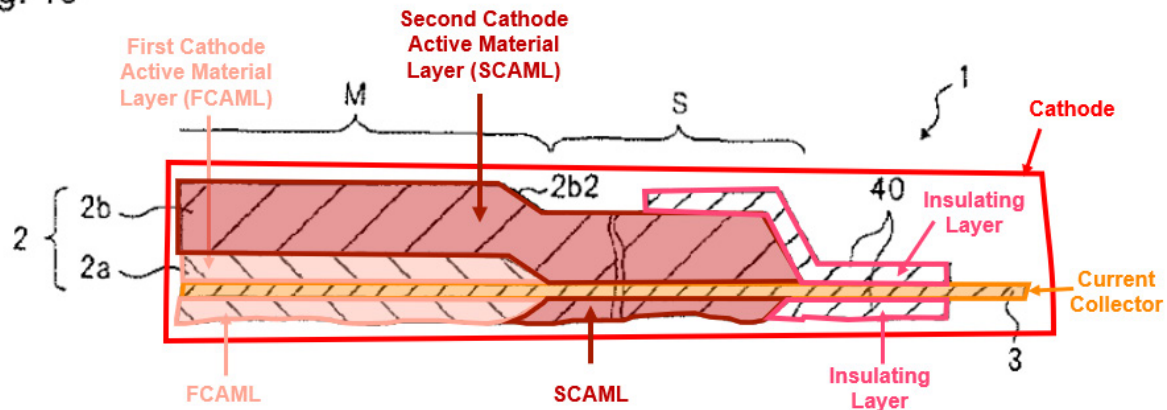
EX1005 (Tanaka), FIG. 2 (annotated).

Fig. 3A



EX1005 (Tanaka), FIG. 3A (annotated).

Fig. 10

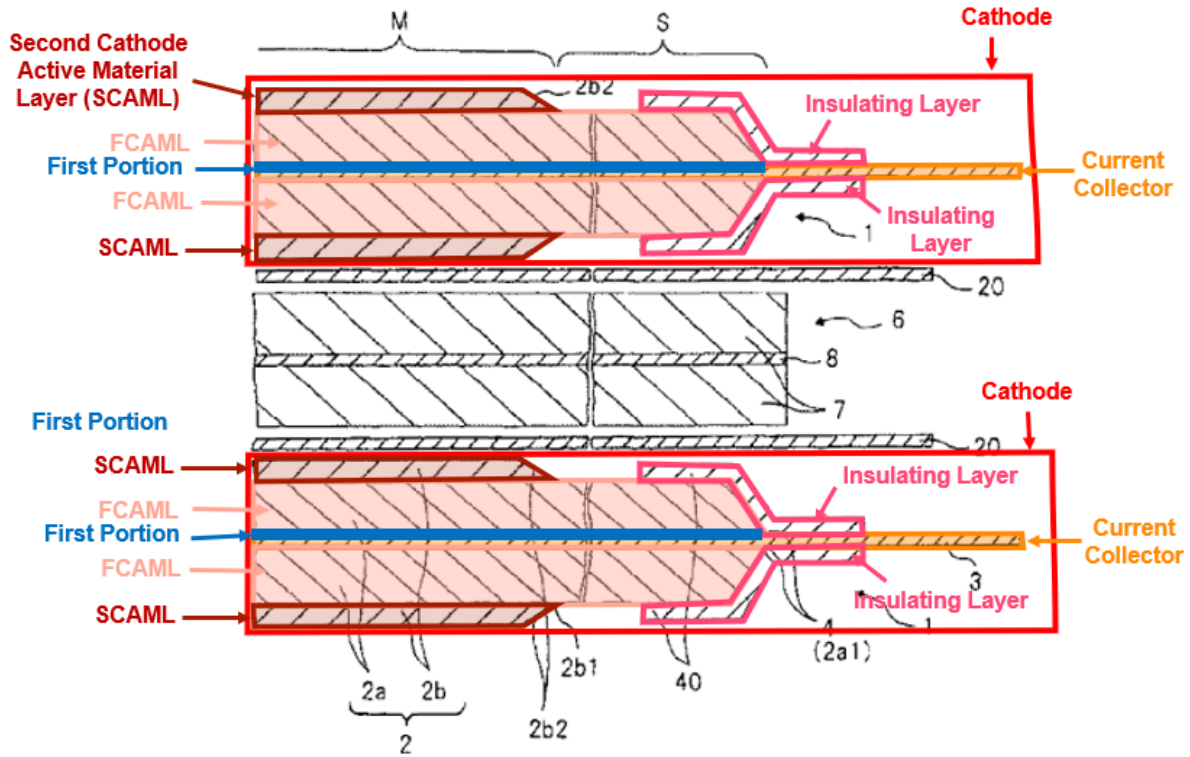


EX1005 (Tanaka), FIG. 10 (annotated).

82. Tanaka's first active material layer 2a is thus disposed between the cathode current collector and the second cathode active material layer as recited in limitation 1.E.1.

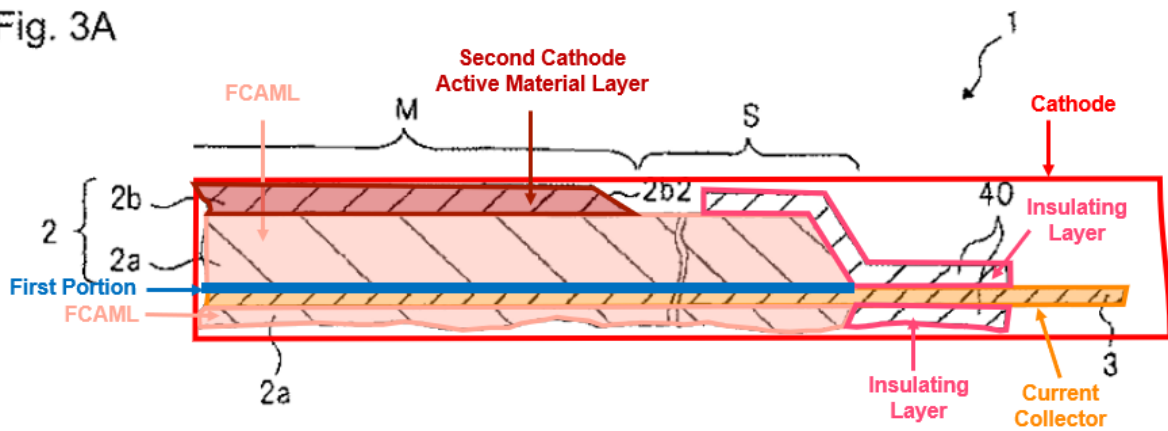
7. **1.E.2: [the first cathode active material layer] covers a first portion of the first surface of the cathode current collector, and**

83. Tanaka discloses that first active material layer 2a is disposed on current collector 3. EX1005 (Tanaka), [0012], [0035], [0050]. Thus, Tanaka's first active material layer 2a covers a portion of the surface of positive electrode current collector 3. *See below* EX1005 (Tanaka), FIGS. 2, 3A, and 10.



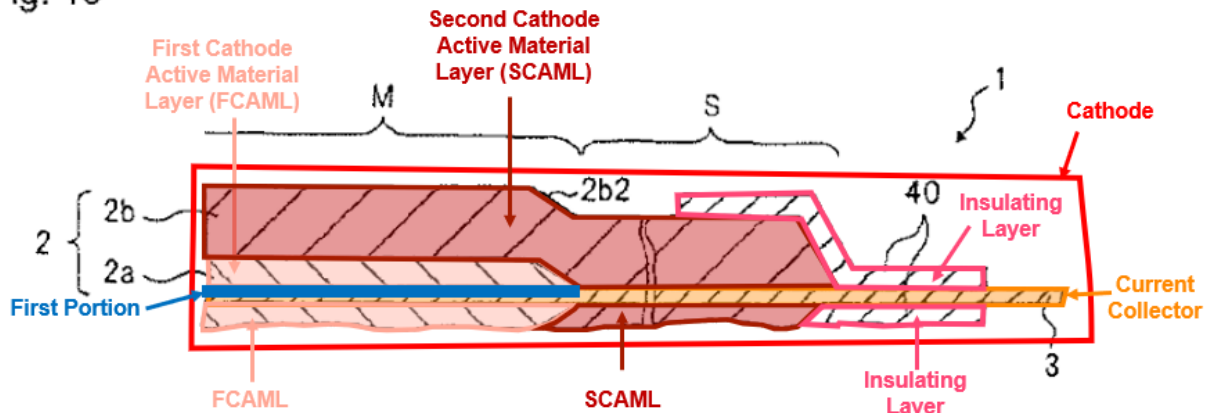
EX1005 (Tanaka), FIG. 2 (annotated).

Fig. 3A



EX1005 (Tanaka), FIG. 3A (annotated).

Fig. 10

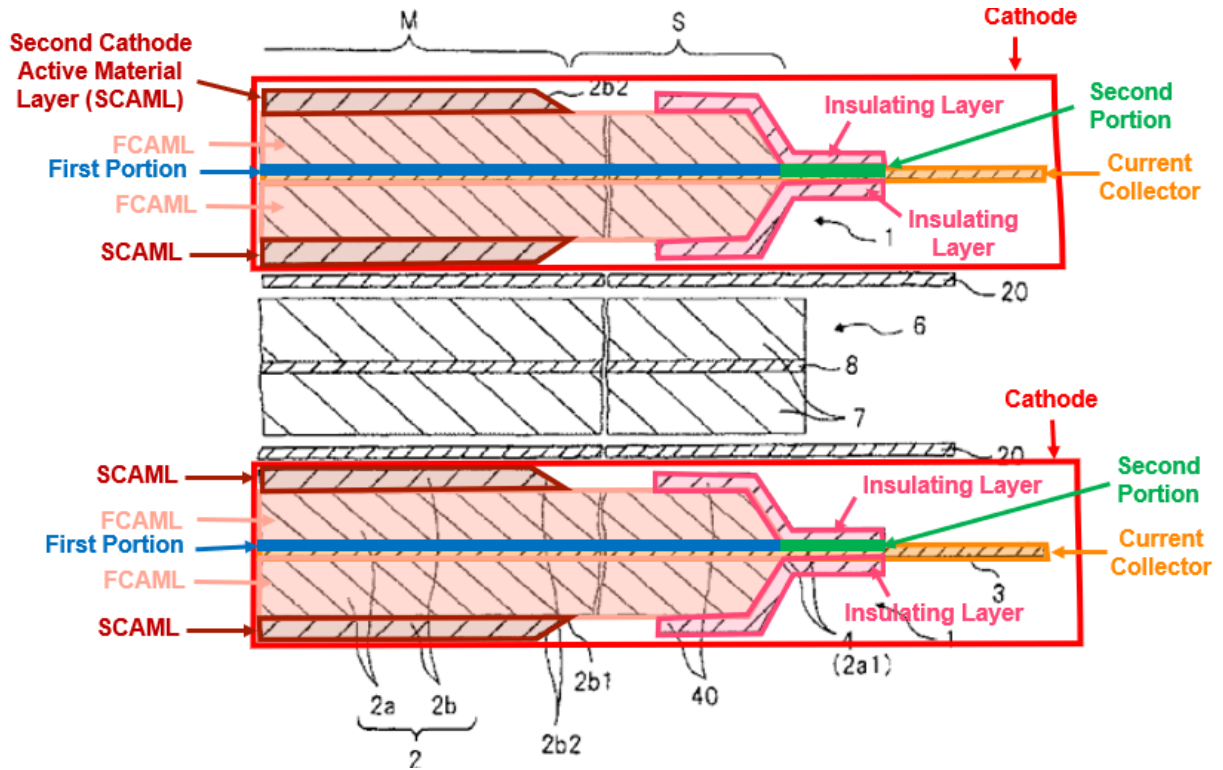


EX1005 (Tanaka), FIG. 10 (annotated).

84. Therefore, Tanaka discloses and explicitly shows that the first cathode active material layer covers a first portion of the first surface of the cathode current collector as recited in limitation [1.E.2].

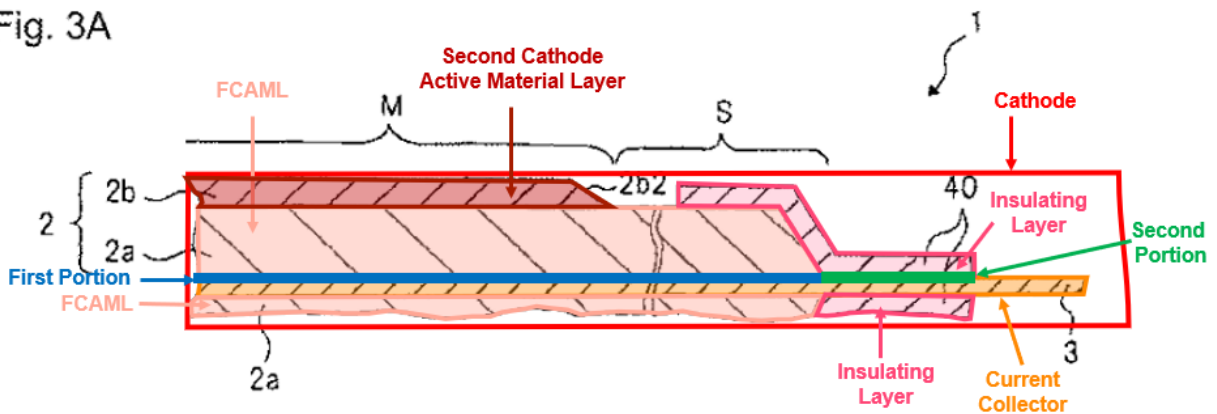
**8. 1.F: the insulating layer covers a second portion of the first surface of the cathode current collector that is different from the first portion,**

85. Tanaka describes that insulating member 40 “is formed across both the non-applied part (positive electrode tab) and positive electrode active material 2 ... so as to cover border part 4.” EX1005 (Tanaka), [0036]. Thus, Tanaka’s insulating member 40 covers not only the border part between applied and non-applied parts, it also extends onto the non-applied part (the claimed “second portion”) that is not covered by the first cathode active material layer. *See* EX1005 (Tanaka), [0051]; *see below* EX1005 (Tanaka), FIGS. 2, 3A, and 10.



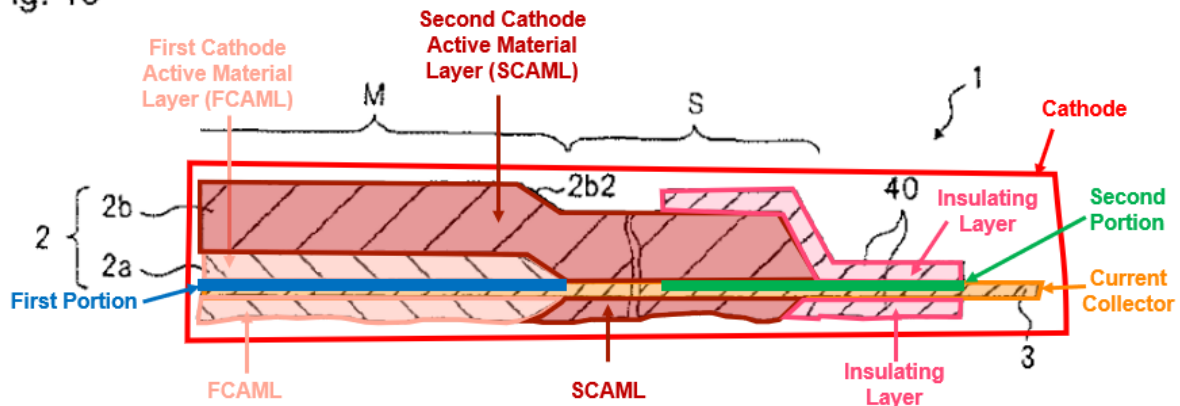
EX1005 (Tanaka), FIG. 2 (annotated).

Fig. 3A



EX1005 (Tanaka), FIG. 3A (annotated).

Fig. 10



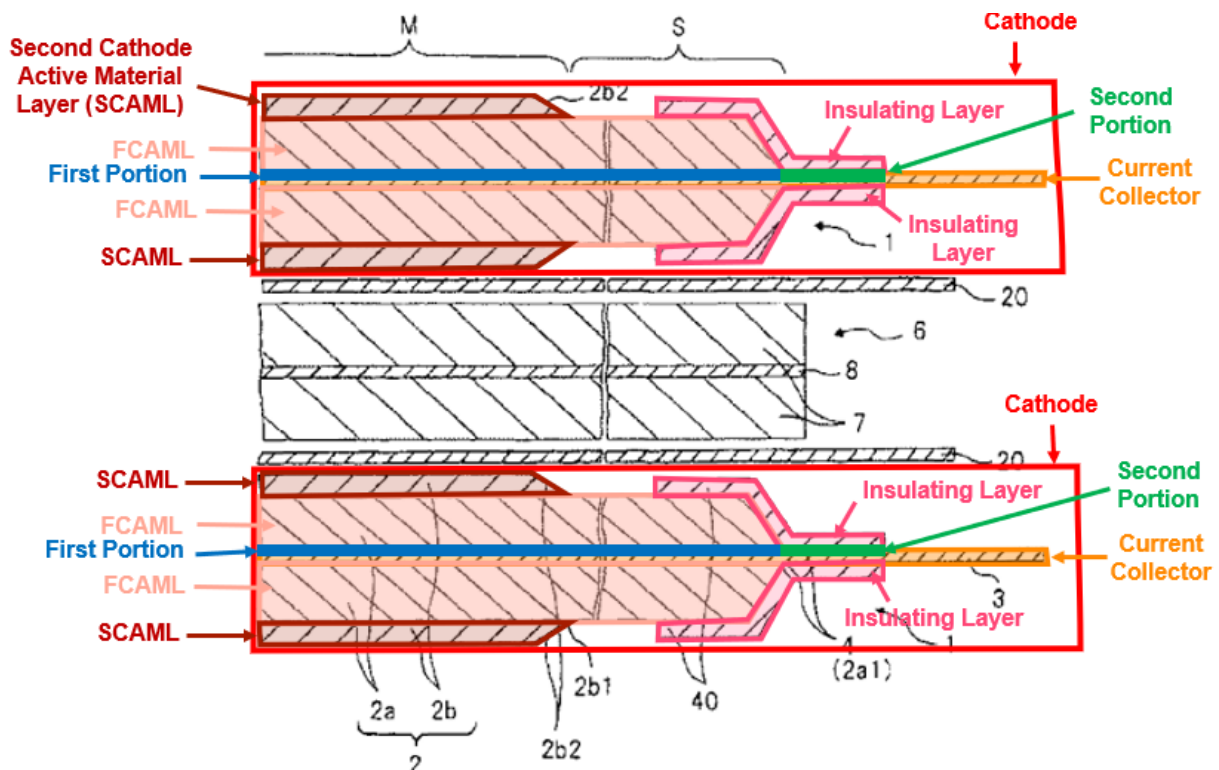
EX1005 (Tanaka), FIG. 10 (annotated).

86. As shown in Figures 2 and 3A of Tanaka above, the portion of the surface of positive electrode current collector 3 that is covered by the first active material layer 2a *abuts* the portion of the surface of positive electrode current collector 3 that is covered by insulating member 40. EX1005 (Tanaka), FIGS. 2 and 3A. Alternatively, as shown in Figure 10 of Tanaka above, the portion of the surface of positive electrode current collector 3 that is covered by the first active material layer 2a *is separated by a non-zero distance from* the portion of the positive electrode current collector 3 that is covered by insulating member 40. EX1005 (Tanaka), FIG. 10. In either case, Tanaka's insulating member 40 covers a second portion of the first surface of the cathode current collector that is *different* from the first portion, as recited by claim [1.F].

**9. 1.G: wherein a thickness of the insulating layer is greater than a thickness of the first cathode active material layer.**

87. Tanaka describes various thicknesses for insulating member 40 and for the first and second active material layers 2a and 2b, respectively. EX1005 (Tanaka), [0038], [0051], [0065], [0071], FIG. 2. These disclosures by Tanaka disclose this claim element in at least two different ways.

88. First, Tanaka at least inherently discloses this claim element. In particular, Tanaka describes that first active material layer 2a “may slope” from its average thickness towards a thickness of zero at positive current collector 3. EX1005 (Tanaka), [0051]; *see below* EX1005 (Tanaka), FIG. 2.

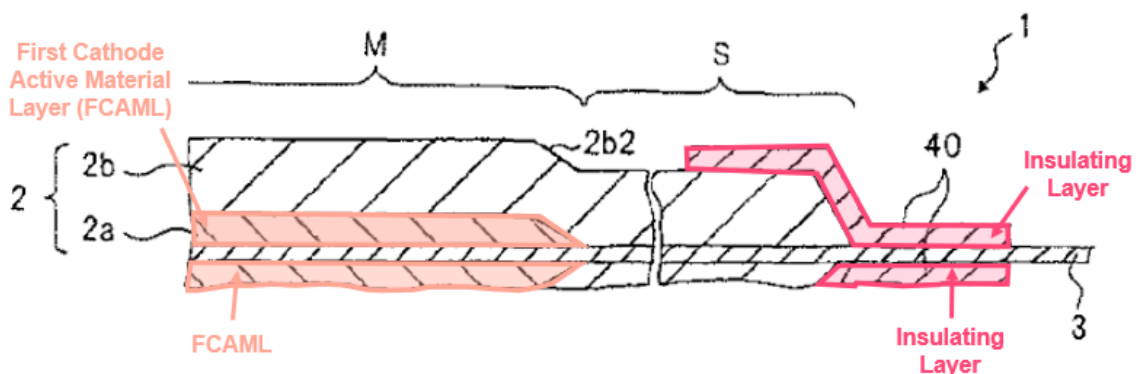


EX1005 (Tanaka), FIG. 2 (annotated).

89. A POSA would understand that, at some point along its slope toward zero, Tanaka's first active material layer 2a **must necessarily** have a thickness that is less than the thickness of insulating member 40. EX1005 (Tanaka), [0051].

90. Although the above disclosure by Tanaka is all that is required to satisfy this feature of claim 1, Tanaka goes further, describing that insulating member 40 may have a thickness of preferably "90% or less of the average thickness of multi-layer part M" (e.g., the sum of the thicknesses of the first and second active material layers). EX1005 (Tanaka), [0051]. Tanaka also discloses exemplary thicknesses of 20  $\mu\text{m}$  and 40  $\mu\text{m}$  for insulating member 40. EX1005 (Tanaka), [0065].

91. In addition, as a specific example of the embodiment shown in Figure 10, Tanaka describes that "the average thickness of first active material layer 2a is 0.04 mm" and "the average thickness of second active material layer 2b is 0.1 mm," and insulating member 40 may have a thickness of 0.03 mm. EX1005 (Tanaka), [0071], [0073]-[0074]; *see below* EX1005 (Tanaka), FIG. 10.



EX1005 (Tanaka), FIG. 10 (annotated).

92. However, a POSA would understand, based on paragraph [0051] of EX1005 (Tanaka), that the example in FIG. 10 is not limited to insulating member 40 having a thickness of 0.03 mm. Instead, a POSA would understand that insulating member 40 may have a thickness that satisfies all the teachings of Tanaka so long as insulating member 40 has a thickness that is less than or equal to 90% or less of 0.14 mm (that is, less than or equal to .126 mm) or more preferably that is less than or equal to 60% or less of 0.14 mm (that is, less than or equal to 0.084 mm). A POSA would understand that either of these thicknesses, and any thickness in between these described thicknesses, would be greater than the thickness of the first active material layer 2a in this example (e.g., 0.04 mm) while still achieving all the benefits described by Tanaka. *See, e.g.*, EX1005 (Tanaka), [0051].

93. Tanaka thus discloses to a POSA that insulating member 40 may have a thickness (e.g., equal to 0.084 mm up to 0.126 mm) that is greater than the thickness of first active material layer 2a (e.g., 0.04 mm). Accordingly, Tanaka discloses this claim element for at least this reason as well.

**B. Claim 2**

**1. [2.P] The cathode according to claim 1, wherein**

94. Tanaka discloses all the elements of claim 1. *See above* § XI.A.

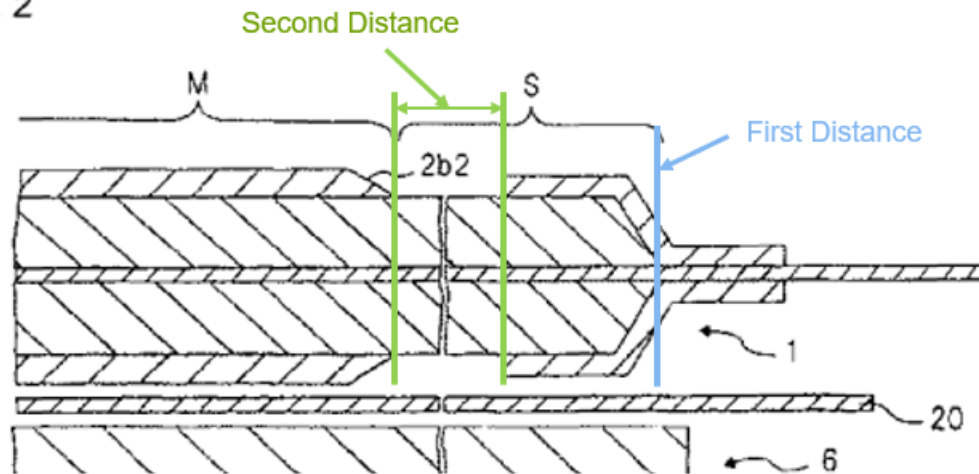
95. Regarding the claimed “first distance” and “second distance,” the claims and even the disclosure of the ’769 patent allow for either or both of the first distance and the second distance to be zero. *See below* [2.B]; *see also* EX1001 (’769 patent), 6:64-7:6 (“**the first distance and the second distance are respectively greater than or equal to 0** and the second distance is less than or equal to the first distance”) (emphasis added).

2. [2.A] **a first distance exists between the insulating layer and the first cathode active material layer in a longitudinal direction of the cathode current collector, a second distance exists between the insulating layer and the second cathode active material layer in the longitudinal direction of the cathode current collector; and**

96. Tanaka discloses that the termination positions of first and second active material layers 2a and 2b may be “deviated in a planar direction,” and that insulating member 40 covers the “border part between the applied part and the non-applied part” of cathode current collector 3.” EX1005 (Tanaka), [0012], [0068]. In one embodiment shown in Figures 2 and 3A, Tanaka’s first active material layer 2a extends beyond second active material layer 2b and under insulating member 40, so that the “termination position 2a1 of the first active material layer 2a is closer to an outer edge of the battery electrode assembly than termination position 2b1 of second active material layer 2b.” EX1005 (Tanaka), [0035]. In this case, the claimed first distance is zero and the second distance is

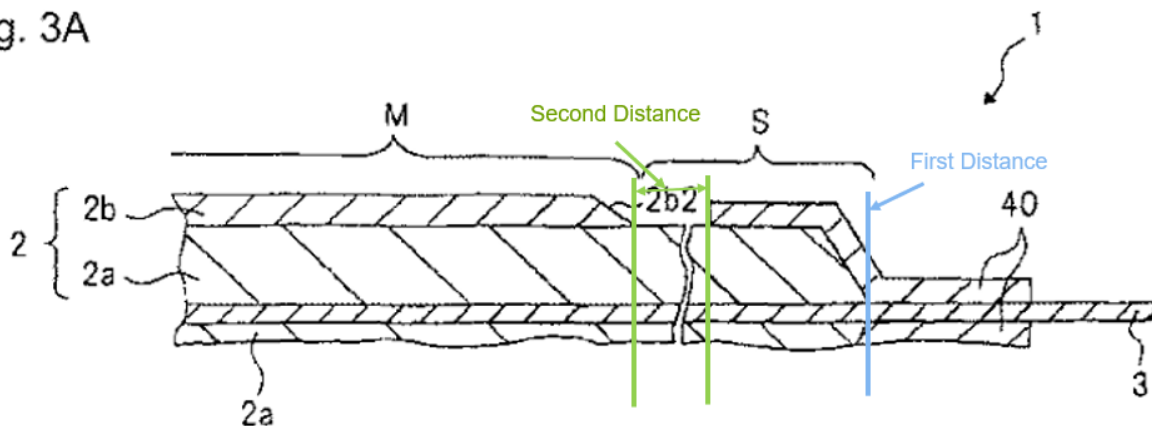
greater than zero. EX1005 (Tanaka), [0035]-[0036]; *see below* EX1005 (Tanaka), FIGS. 2, 3A.

Fig. 2



EX1005 (Tanaka), FIG. 2 (abridged, annotated).

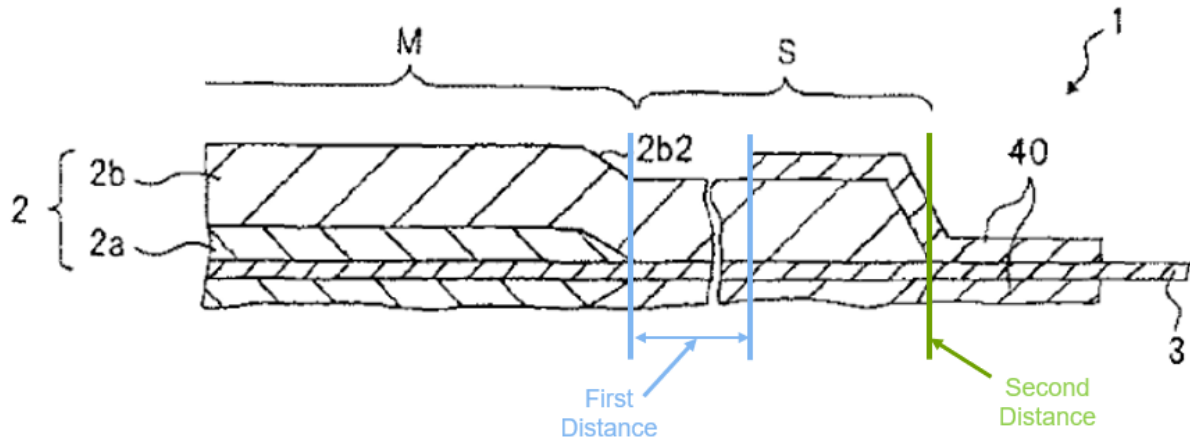
Fig. 3A



EX1005 (Tanaka), FIG. 3A (annotated).

97. In a second embodiment shown in Figure 10, Tanaka discloses that “second active material layer 2b may extend beyond the end part of the applied part of first active material layer 2a, and the single-layer part may be configured by second active material layer 2b.” EX1005 (Tanaka), [0071]; *see below* EX1005

(Tanaka), FIG. 10. In this case, the claimed second distance is zero and the claimed first distance is greater than zero.



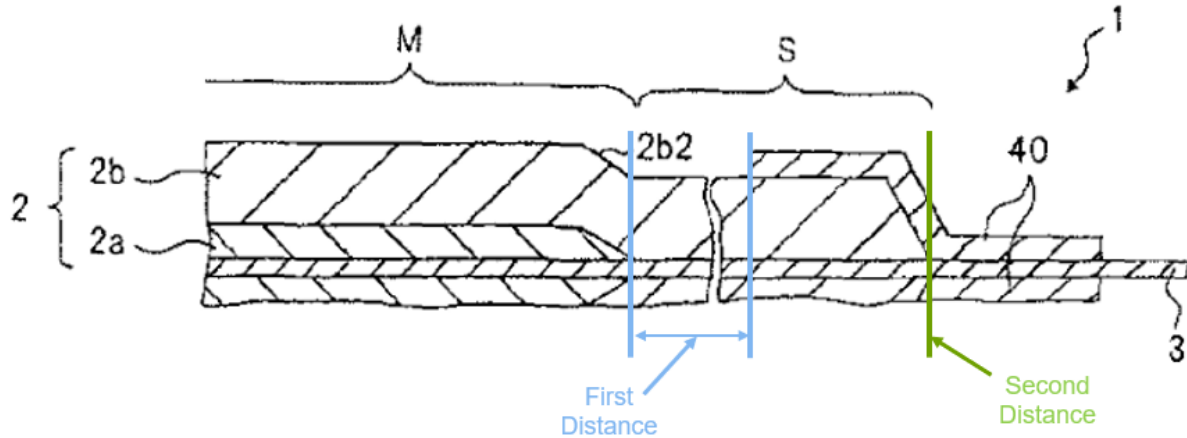
EX1005 (Tanaka), FIG. 10 (annotated).

3. **[2.B] the first distance and the second distance are respectively greater than or equal to 0 and the second distance is less than or equal to the first distance.**

98. Tanaka expressly discloses this claim element. In particular, Tanaka describes that the single-layer part S, which is partially covered by insulating member 40, “may be configured by second active material 2b.” EX1005 (Tanaka), [0071]. Thus, the distance between second active material layer 2b and insulating member 40 (the claimed “second distance”) is zero, which logically must be “less than or equal to” *any value* for the distance between the end of first active material layer 2a and insulating member 40, even including a distance of zero.

99. Tanaka also inherently discloses this claim element. For example, Figure 10 of Tanaka shows an embodiment in which the second distance is

approximately zero and the first distance is greater than zero. *See below*, EX1005 (Tanaka), FIG. 10.



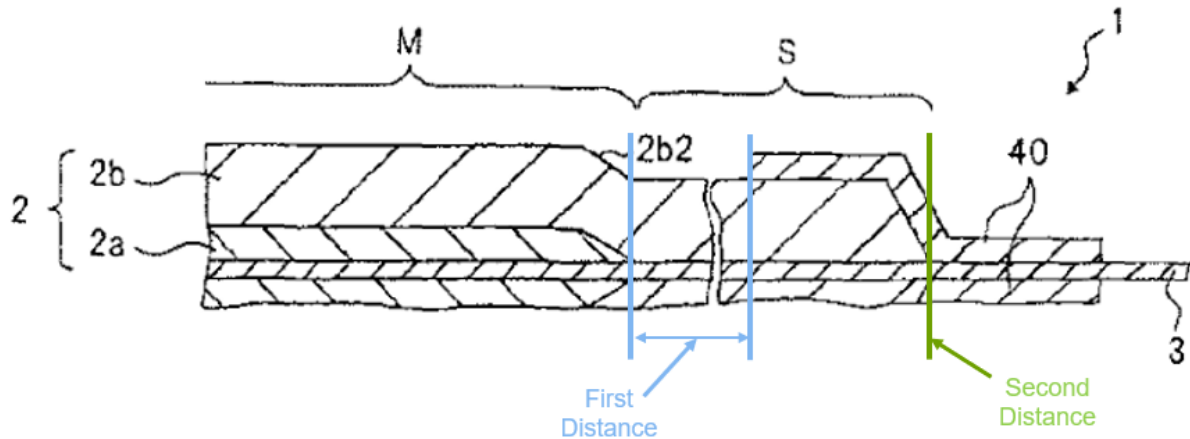
EX1005 (Tanaka), FIG. 10 (annotated).

100. Thus, the second distance in Figure 10 of Tanaka (e.g., zero) **must necessarily** be less than or equal to the first distance (e.g., greater than zero), as recited in claim limitation [2.B].

**C. Claim 3. The cathode according to claim 2, wherein the first distance is from about 0 mm to about 83 mm.**

101. Tanaka discloses that the distance between the termination of first active material layer 2a and the termination of second active material layer 2b may be “0.5 to 5 mm, and more preferably, is 0.5 to 3 mm.” EX1005 (Tanaka), [0066]. Tanaka’s insulating member 40 partially overlaps second active material layer 2b as shown below in Figure 10 of Tanaka. Thus, the distance between the termination of first active material layer 2a and the end of insulating member 40 (the claimed “first distance”) will be greater than zero but less than the distance of

“0.5 to 5 mm” disclosed by Tanaka. EX1005 (Tanaka), [0066]. This range of distances is narrower than and overlaps, and therefore anticipates, the range of “from about 0 mm to about 83 mm” recited by claim 3.



EX1005 (Tanaka), FIG. 10 (annotated).

**D. Claim 4. The cathode according to claim 1, wherein the second cathode active material layer completely covers a surface of the first cathode active material layer.**

102. Tanaka discloses that, in the embodiment shown in Figure 10, second active material layer 2b is formed with “a part or a whole of the second active material layer being positioned on the first active material layer” and formed so that “the end part of the applied part of the second active material layer is positioned on the current collector beyond the end part of the applied part of the first active material layer.” EX1005 (Tanaka), [0012], [0066]; *see also* EX1005 (Tanaka), [0071]. A POSA would understand that, in the slurry-based technique described by Tanaka, the slurry for the second active material layer 2b would be

disposed on top of and would flow over the dried first active material layer 2a. *See* EX1005 (Tanaka), [0060]-[0061]. In this configuration, Tanaka's second active material layer 2b would cover and extend beyond first active material layer 2a, so that second active material layer 2b would completely cover the top surface of first active material layer 2a. Accordingly, Tanaka discloses this claim element.

**E. Claim 5. The cathode according to claim 1, wherein the thickness of the first cathode active material layer is from about 0.1  $\mu\text{m}$  to about 20  $\mu\text{m}$ .**

103. Tanaka discloses that the active material layer (layers 2a and 2b) may have a thickness of "about 5 to 200  $\mu\text{m}$ ." EX1005 (Tanaka), [0064]. Tanaka also discloses that "the difference in thickness between multi-layer part M" (including both first and second active material layers) "and single-layer part S" (including only one of the first and second active material layers) may be "10  $\mu\text{m}$  to 70  $\mu\text{m}$ ." EX1005 (Tanaka), [0065]. Thus, the thickness of Tanaka's first active material layer 2a may be from less than 5  $\mu\text{m}$  (when the total thickness is 5  $\mu\text{m}$ ) up to at least 70  $\mu\text{m}$ . EX1005 (Tanaka), [0065]. Tanaka's range of less than 5  $\mu\text{m}$  up to 70  $\mu\text{m}$  substantially overlaps, and therefore anticipates, the claimed range of 0.1 to 20  $\mu\text{m}$  recited by claim 5.

**F. Claim 6. The cathode according to claim 1, wherein the first cathode active material and the second cathode active material are each independently selected from the group consisting of lithium cobaltate, lithium iron phosphate, lithium manganese iron phosphate, sodium iron phosphate, lithium vanadium phosphate, sodium vanadium phosphate, oxy-lithium-vanadium phosphate,**

**oxy-sodium-vanadium phosphate, lithium vanadate, lithium manganate, lithium nickelate, lithium nickel cobalt manganese oxide, lithium-rich manganese-based material, lithium nickel cobalt aluminum oxide, lithium titanate and combinations thereof.**

104. Tanaka discloses that “as the active material composing positive electrode active material layer 2, for example ...  $\text{LiCoO}_2$ ,  $\text{LiNiO}_2$ ,  $\text{LiNi}_{(1-x)}\text{CoO}_2$ ,  $\text{LiNi}_x(\text{CoAl})_{(1-x)}\text{O}_2$ ,  $\text{Li}_2\text{MO}_3$ — $\text{LiMO}_2$  and  $\text{LiNi}_{1/3}\text{Co}_{1/3}\text{Mn}_{1/3}\text{O}_2$ , ...  $\text{LiMn}_2\text{O}_4$ ,  $\text{LiMn}_{1.5}\text{Ni}_{0.5}\text{O}_4$  and  $\text{LiMn}_{(2-x)}\text{M}_x\text{O}_4$ , ...  $\text{LiMPO}_4$ , ...  $\text{Li}_2\text{MPO}_4\text{F}$  and  $\text{Li}_2\text{MSiO}_4\text{F}$ , and vanadium oxide materials such as  $\text{V}_2\text{O}_5$  can be used, and mixtures of two or more kinds of them can also be used.” EX1005 (Tanaka), [0040]. Tanaka further describes that “[t]he positive electrode active material mixture agent of first active material layer 2a and the positive electrode active material mixture agent of second active material layer 2b ... **may be different.**” EX1005 (Tanaka), [0035] (emphasis added). Thus, Tanaka discloses that the first cathode active material and the second cathode active material are each independently selected from the group of materials recited by claim 6.

**G. Claim 7**

**1. [7.P] The cathode according to claim 1, wherein**

105. Tanaka discloses or at least suggests all the elements of claim 1. *See above* § XI.A.

2. **[7.A] the first cathode active material layer and the second cathode active material layer each further comprise a binder and a conductive agent, wherein**

106. Tanaka discloses that “[t]he active material mixture agent that forms positive electrode active material layer 2 ... is an agent in which **a binding agent, a conductive assistant** and the like are appropriately added in the above-described active material.” EX1005 (Tanaka), [0042] (emphasis added). Thus, Tanaka discloses that each active material layer 2a and 2b includes a binder and a conductive agent, as recited in limitation [7.A].

3. **[7.B] the binder is selected from the group consisting of polyvinylidene fluoride, a vinylidene fluoride-hexafluoropropylene copolymer, polyamide, polyacrylonitrile, polyacrylate ester, polyacrylic acid, polyacrylate salt, sodium carboxymethyl cellulose, polyvinylpyrrolidone, polyvinyl ether, polymethyl methacrylate, polytetrafluoroethylene, polyhexafluoropropylene, styrene butadiene rubber and combinations thereof; and**

107. Tanaka further describes that, for the binding agent, “**polyvinylidene fluoride, polytetrafluoroethylene, carboxymethyl cellulose**, denatured acrylonitrile rubber particles and the like can be used.” EX1005 (Tanaka), [0042] (emphasis added). Thus, Tanaka discloses a binder selected from the Markush group recited by limitation [7.B].

4. **[7.C] the conductive agent is selected from the group consisting of carbon nanotubes, conductive carbon black, acetylene black, graphene, Ketjen black, carbon fibers and combinations thereof.**

108. Tanaka also describes that, “[a]s the conductive assistant, **carbon black, carbon fiber**, graphite and the like can be used and combinations of two or more kinds of them can also be used.” EX1005 (Tanaka), [0042]. Thus, Tanaka discloses a conductive agent selected from the Markush group recited by limitation [7.C].

- H. **Claim 8. The cathode according to claim 1, wherein the insulating layer comprises at least one of inorganic particles and a polymer, wherein the inorganic particles are selected from the group consisting of aluminum oxide, silicon dioxide, magnesium oxide, titanium oxide, hafnium oxide, tin oxide, cerium dioxide, nickel oxide, zinc oxide, calcium oxide, zirconium dioxide, yttrium oxide, silicon carbide, boehmite, aluminum hydroxide, magnesium hydroxide, calcium hydroxide, barium sulfate and combinations thereof; and the polymer is selected from the group consisting of a homopolymer of vinylidene fluoride, a copolymer of vinylidene fluoride, a copolymer of hexafluoropropylene, polystyrene, polyphenylacetylene, sodium poly(vinyl acid), potassium poly(vinyl acid), polymethyl methacrylate, polyethylene, polypropylene, polytetrafluoroethylene and combinations thereof.**

109. Tanaka discloses that “[f]or insulating member 40 ... polyimide, glass fiber, polyester, **polypropylene**, or materials containing them can be used.” EX1005 (Tanaka), [0048]. Thus, Tanaka discloses an insulating layer comprising a polymer that is polypropylene, which is selected from the Markush group recited by claim 8.

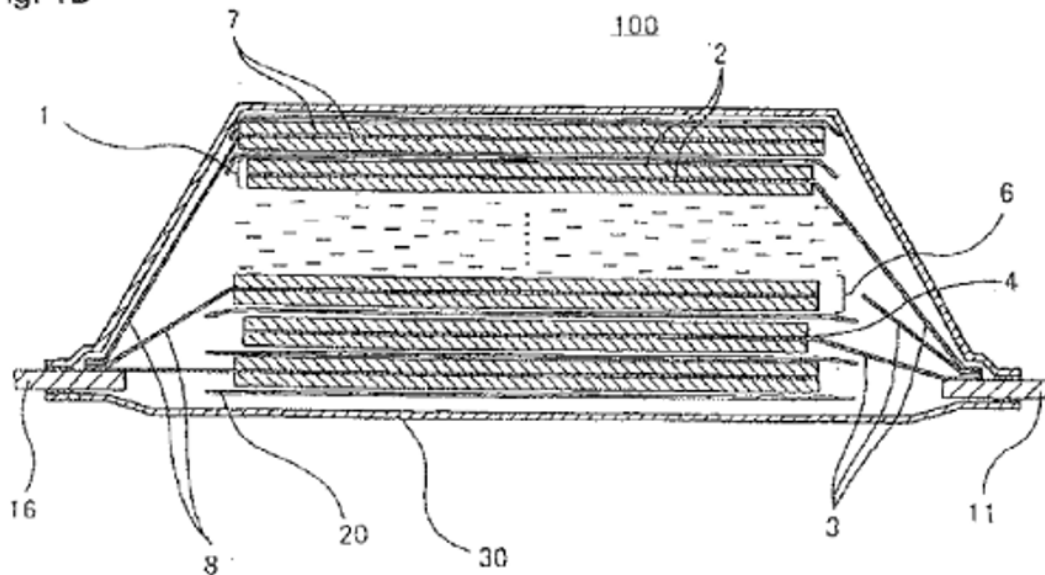
**XII. GROUND 1B: CLAIMS 9-13 AND 15-18 ARE OBVIOUS OVER TANAKA**

**A. Independent Claim 9**

**1. 9.P. An electrochemical device, comprising**

110. Tanaka discloses a “lithium-ion secondary battery” comprising a “battery electrode assembly” “in which positive electrodes ... and negative electrodes ... are alternately laminated with separator 20 interposed therebetween such that layers are formed.” EX1005 (Tanaka), [0030]-[0031]; *see below* EX1005 (Tanaka), FIG. 1B.

Fig. 1B



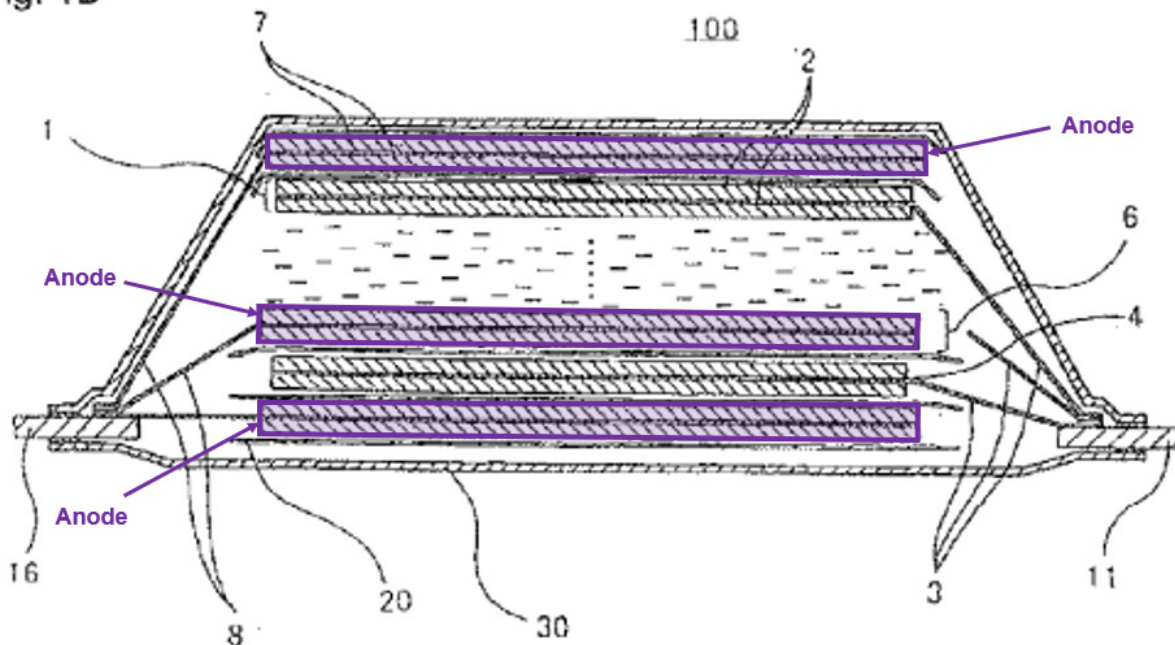
EX1005 (Tanaka), FIG. 1B.

111. This is the same kind of electrochemical device used in the same context for the same purpose as that of the '769 patent.

**2. 9.A: an anode,**

112. Tanaka discloses that “[l]ithium-ion secondary battery 100” includes “negative electrodes” (the claimed “anode”) that are “alternately laminated” with positive electrodes. EX1005 (Tanaka), [0031]; *see below* EX1005 (Tanaka), FIG. 1B.

Fig. 1B



EX1005 (Tanaka), FIG. 1B (annotated).

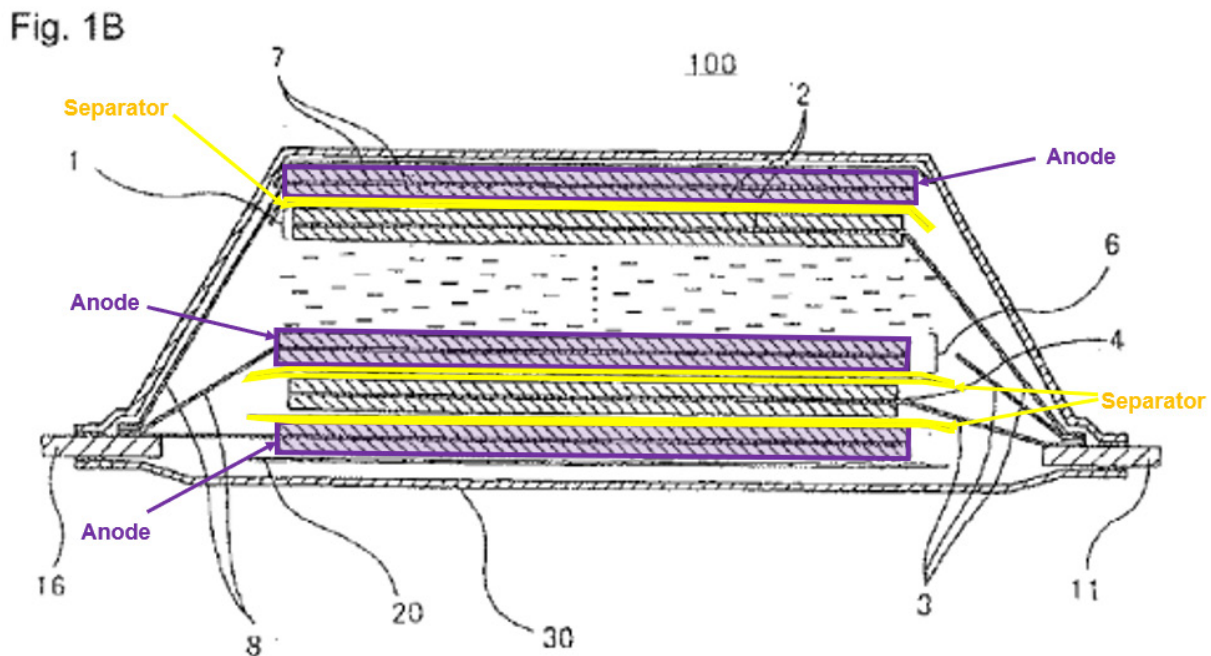
113. Tanaka’s negative electrode 6 includes a “negative electrode active material,” such as “carbon materials such as graphite, amorphous carbon, diamond-like carbon, fullerene, carbon nanotube and carbon nanohorn or the like, lithium metal material, alloy materials of silicon, tin, and the like, oxide materials such as Nb<sub>2</sub>O<sub>5</sub> and TiO<sub>2</sub>, or composites of them,” and “a terminal composed of copper or

a copper alloy, or a terminal composed of copper or a copper alloy and plated with nickel, or the like.” EX1005 (Tanaka), [0039], [0041], [0047].

114. Tanaka’s negative electrode 6 is the same as the anode recited by limitation [9.A].

### 3. 9.B: a separator and

115. Tanaka discloses that “[l]ithium-ion secondary battery 100” includes “a separator” disposed between the negative electrode (the claimed “anode”) and the positive electrode (the claimed “cathode”). EX1005 (Tanaka), Abstract, FIG. 1B.



EX1005 (Tanaka), FIG. 1B (annotated).

116. Tanaka’s “[s]eparator 20 is mainly formed of a plastic porous membrane, woven fabric or non-woven fabric, or the like,” for example “a

polyolefin-based microporous membrane” to “provide[] excellent separation between the positive and negative electrodes” while also having “excellent ion permeability.” EX1005 (Tanaka), [0045]. Thus, Tanaka’s separator 20 is the same as the separator recited by limitation [9.B].

**4. 9.C: a cathode, wherein the cathode comprises**

117. Tanaka discloses a cathode as discussed above regarding limitation [1.P]. *See above* § XI.A.1.

**5. 9.D: a cathode current collector, having a first surface;**

118. Tanaka discloses a cathode current collector having a first surface, as discussed above regarding limitation [1.A]. *See above* § XI.A.2.

**6. 9.E: a first cathode active material layer, comprising a first cathode active material;**

119. Tanaka discloses a first cathode active material layer comprising a first cathode active material, as discussed above regarding limitation [1.B]. *See above* § XI.A.3.

**7. 9.F: a second cathode active material layer, comprising a second cathode active material; and**

120. Tanaka discloses a second cathode active material layer comprising a second cathode active material, as discussed above regarding limitation [1.C]. *See above* § XI.A.4.

**8. 9.G: an insulating layer, wherein**

121. Tanaka discloses an insulating layer as discussed above regarding limitation [1.D]. *See above* § XI.A.5.

**9. 9.H.1: the first cathode active material layer is disposed between the cathode current collector and the second cathode active material layer and**

122. Tanaka discloses the first cathode active material layer is disposed between the cathode current collector and the second cathode active material layer, as discussed above regarding limitation [1.E.1]. *See above* § XI.A.6.

**10. 9.H.2: [the first cathode active material layer] covers a first portion of the first surface of the cathode current collector, and**

123. Tanaka discloses the first cathode active material layer covers a first portion of the first surface of the cathode current collector, as discussed above regarding limitation [1.E.2]. *See above* § XI.A.7.

**11. 9.I: the insulating layer covers a second portion of the first surface of the cathode current collector that is different from the first portion,**

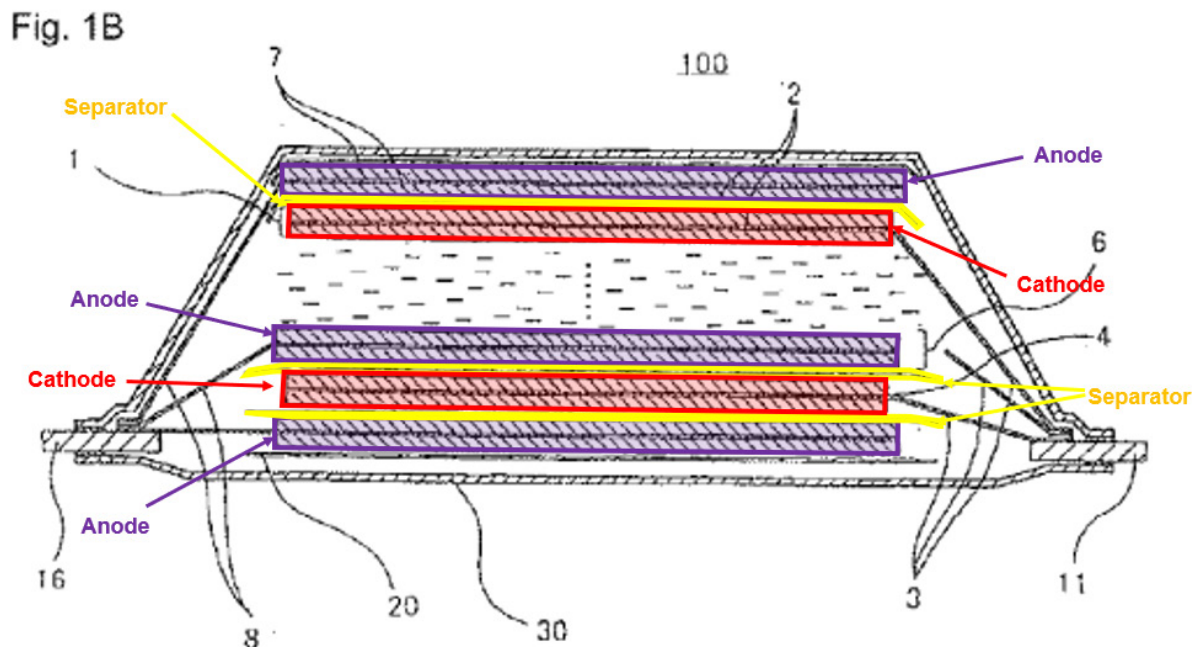
124. Tanaka discloses the insulating layer covers a second portion of the first surface of the cathode current collector that is different from the first portion, as discussed above regarding limitation [1.F]. *See above* § XI.A.8.

**12. 9.J: wherein a thickness of the insulating layer is greater than a thickness of the first cathode active material layer; and**

125. Tanaka discloses a thickness of the insulating layer is greater than a thickness of the first cathode active material layer, as discussed above regarding limitation [1.G]. *See above* § XI.A.9.

**13. 9.K: the separator is disposed between the anode and the cathode,**

126. Tanaka discloses that “positive and negative electrodes [are] alternately laminated with a separator interposed therebetween.” EX1005 (Tanaka), Abstract; *see also* EX1005 (Tanaka), [0054]; *see below* EX1005 (Tanaka), FIG. 1B.



EX1005 (Tanaka), FIG. 1B (annotated).

127. Thus, Tanaka’s separator 20 is disposed between the anode and the cathode as recited in limitation [9.K].

**14. 9.L: and the anode, the separator, and the cathode are wound to form an electrode assembly.**

128. Tanaka explicitly describes that a “wound” type electrode assembly structure was one of two well-known possibilities in the art. EX1005 (Tanaka), [0003]-[0004]. Specifically, Tanaka points out that “[t]he secondary battery can be roughly classified into a wound type and a laminated type,” and that the difference lies merely in whether the electrode sheets “are wound multiple times” or “laminated alternately and repeatedly.” EX1005 (Tanaka), [0003]. In either case, “the battery electrode assembly is contained in a sealed outer container” with terminals that lead out of the outer container. EX1005 (Tanaka), [0004].

129. While Tanaka explicitly discloses a battery having a laminated-type structure, it would have been obvious to a POSA to modify Tanaka to have a wound-type structure. This is because Tanaka’s teachings are not limited to the case of a laminated-type structure, and because a wound-type structure is obvious-to-try as one of two classes of batteries discussed by Tanaka. EX1005 (Tanaka), [0003]-[0004].

130. In my opinion, a POSA would have known that such a wound-type structure is an alternative arrangement to the laminated-type structure explicitly taught by Tanaka. *See, e.g.*, EX1006 (Yamafuku), [0202] (“the electrode assembly of the present embodiment is not limited to a winding type assembly, and for example, the electrode assembly may be a stacked type assembly prepared by stacking a plurality of positive electrodes and a plurality of negative electrodes”).

Thus, a POSA would have been capable of and motivated to rearrange Tanaka's electrode assembly as a wound electrode assembly as a well-known alternative to the laminated electrode assembly explicitly taught by Tanaka.

- B. Claim 10. The electrochemical device according to claim 9, wherein a first distance exists between the insulating layer and the first cathode active material layer in a longitudinal direction of the cathode current collector, a second distance exists between the insulating layer and the second cathode active material layer in the longitudinal direction of the cathode current collector; and the first distance and the second distance are respectively greater than or equal to 0 and the second distance is less than or equal to the first distance.**

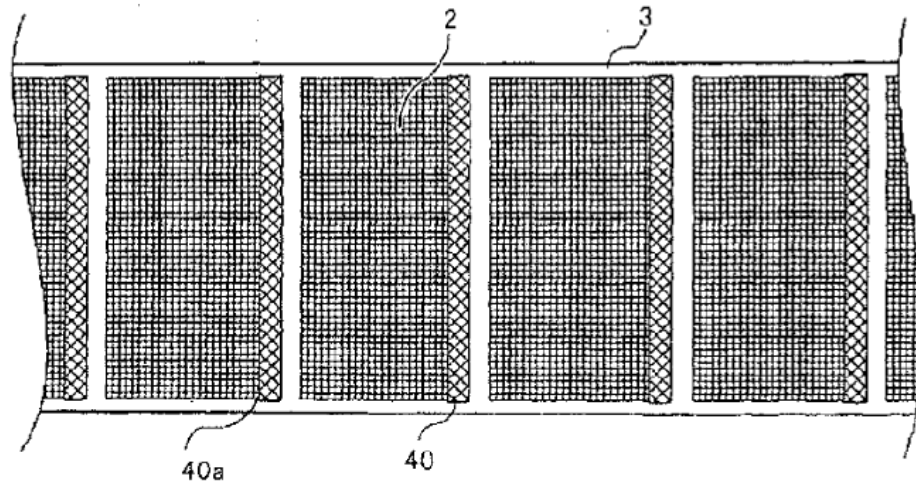
131. Tanaka discloses these claim elements for the same reasons as those discussed above regarding claim 2. *See above* § XI.B.

- C. Claim 11. The electrochemical device according to claim 10, wherein the first distance and the second distance are disposed at a corner of the electrode assembly.**

132. Tanaka discloses that “insulating member 40 is formed so as to cover border part 4 between the applied part where positive electrode active material layer 2 is formed and the non-applied part where positive electrode active material layer 2 is not formed.” EX1005 (Tanaka), [0036]. Figures 5 and 6 of Tanaka show that Tanaka's positive electrode current collector 3 “is cut out and divided along cutting lines 90 shown by broken lines in FIG. 6A,” so that at least one insulating member 40, and thus the first distance and the second distance, are all disposed at a corner of the resulting electrode assembly. EX1005 (Tanaka), [0051]. Thus,

Tanaka discloses that the first and second distances are disposed at a corner of the electrode assembly, as recited by claim 11.

Fig. 5



EX1005 (Tanaka), FIG. 5.

Fig. 6A

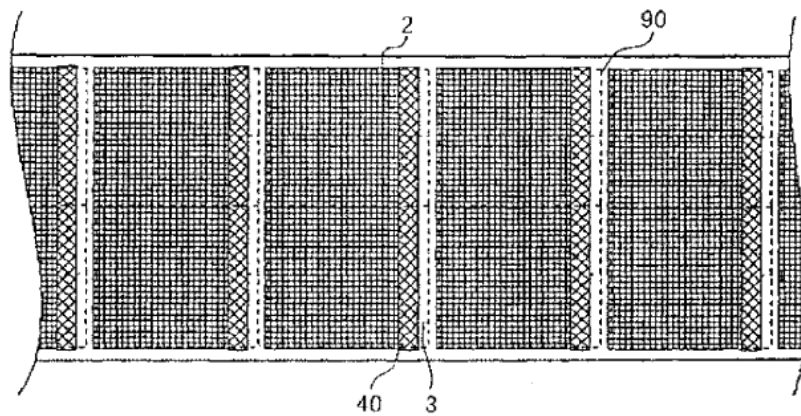
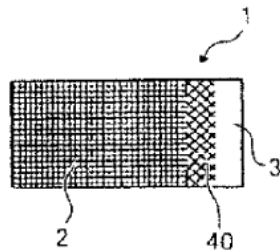


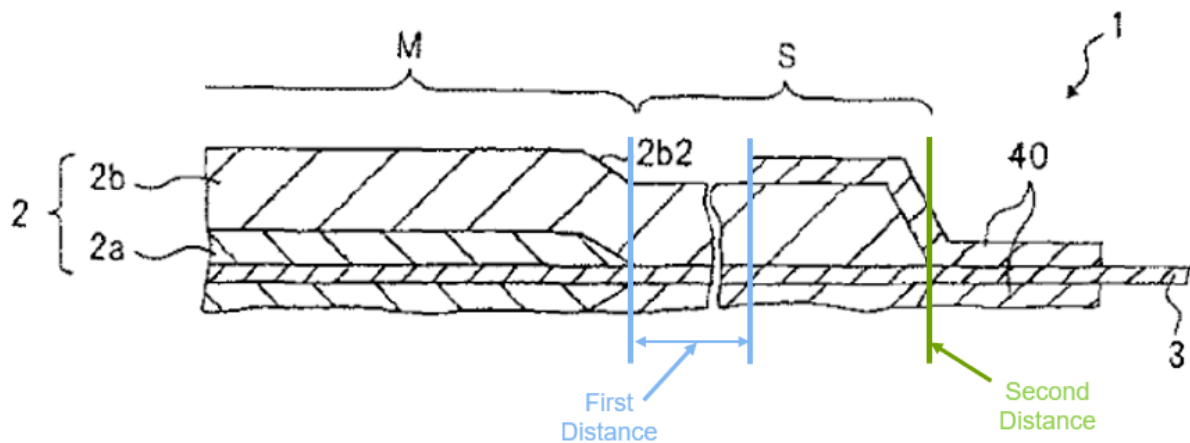
Fig. 6B



EX1005 (Tanaka), FIGS. 6A and 6B.

- D. Claim 12. The electrochemical device according to claim 10, wherein the first distance between the insulating layer and the first cathode active material layer in the longitudinal direction of the cathode current collector satisfies the following formula:  $0 \leq \text{the first distance} \leq \pi/4 D + 4 \text{ mm}$ .**

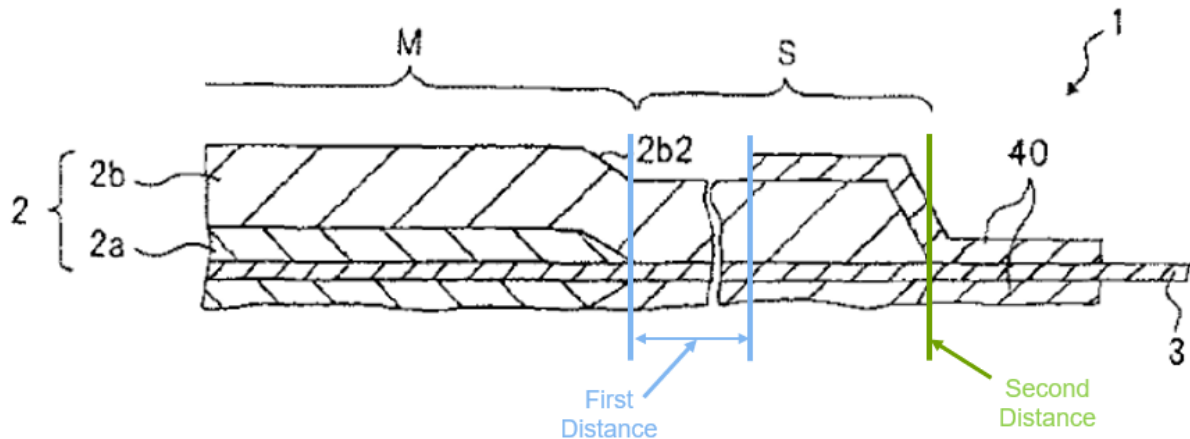
133. Tanaka discloses a first distance between the termination end of first cathode active layer 2a and insulating member 40. *See above* § XI.B.3. The separation between the termination part of first active material layer 2a and the end of insulating member 40 is less than the distance of 0.5-5 mm, and preferably less than 0.5-3 mm. *See above* § XI.C. This distance is implicitly less than any distance  $\pi/4 D + 4 \text{ mm}$  (which must be greater than at least 4 mm).



EX1005 (Tanaka), FIG. 10 (annotated).

- E. Claim 13. The electrochemical device according to claim 10, wherein the second distance between the insulating layer and the second cathode active material layer in the longitudinal direction of the cathode current collector satisfies the following formula:  $0 \leq \text{the second distance} \leq \pi/4 D + 4 \text{ mm}$ .**

134. Tanaka discloses a second distance between the termination end of second cathode active layer 2b and insulating member 40 that may be 0 mm. *See above* § XI.B.3.



EX1005 (Tanaka), FIG. 10 (annotated).

**F. Independent Claim 15**

**1. 15.P: An electronic device, comprising**

135. Tanaka discloses that the electrochemical device may be used for various electronic devices, such as “a portable electronic device, an electric bicycle, an electric assist bicycle, a stationary charger, an electric vehicle, a hybrid vehicle or the like.” EX1005 (Tanaka), [0064].

**2. 15.A: an electrochemical device, wherein the electrochemical device comprises**

136. Tanaka discloses an electrochemical device, as discussed above regarding limitation [9.P]. *See above* § XII.A.1.

**3. 15.B: an anode,**

137. Tanaka discloses an anode, as discussed above regarding limitation [9.A]. *See above* § XII.A.2.

**4. 15.C: a separator and**

138. Tanaka discloses a separator, as discussed above regarding limitation [9.B]. *See above* § XII.A.3.

**5. 15.D: a cathode, wherein the cathode comprises**

139. Tanaka discloses a cathode, as discussed above regarding limitation [1.P]. *See above* § XI.A.1.

**6. 15.E: a cathode current collector, having a first surface;**

140. Tanaka discloses a cathode current collector having a first surface, as discussed above regarding limitation [1.A]. *See above* § XI.A.2.

**7. 15.F: a first cathode active material layer, comprising a first cathode active material;**

141. Tanaka discloses a first cathode active material layer comprising a first cathode active material, as discussed above regarding limitation [1.B]. *See above* § XI.A.3.

**8. 15.G: a second cathode active material layer, comprising a second cathode active material; and**

142. Tanaka discloses a second cathode active material layer comprising a second cathode active material, as discussed above regarding limitation [1.C]. *See above* § XI.A.4.

**9. 15.H: an insulating layer, wherein**

143. Tanaka discloses an insulating layer, as discussed above regarding limitation [1.D]. *See above* § XI.A.5.

**10. 15.I.1: the first cathode active material layer is disposed between the cathode current collector and the second cathode active material layer and**

144. Tanaka discloses the first cathode active material layer is disposed between the cathode current collector and the second cathode active material layer, as discussed above regarding limitation [1.E.1]. *See above* § XI.A.6.

**11. 15.I.2: [the first cathode active material layer] covers a first portion of the first surface of the cathode current collector, and**

145. Tanaka discloses the first cathode active material layer covers a first portion of the first surface of the cathode current collector, as discussed above regarding limitation [1.E.2]. *See above* § XI.A.7.

- 12. 15.J: the insulating layer covers a second portion of the first surface of the cathode current collector that is different from the first portion,**

146. Tanaka discloses the insulating layer covers a second portion of the first surface of the cathode current collector that is different from the first portion, as discussed above regarding limitation [1.F]. *See above* § XI.A.8.

- 13. 15.K: wherein a thickness of the insulating layer is greater than a thickness of the first cathode active material layer; and**

147. Tanaka discloses a thickness of the insulating layer is greater than a thickness of the first cathode active material layer, as discussed above regarding limitation [1.G]. *See above* § XI.A.9.

- 14. 15.L: the separator is disposed between the anode and the cathode,**

148. Tanaka discloses the separator is disposed between the anode and the cathode, as discussed above regarding limitation [9.K]. *See above* § XII.A.13.

- 15. 15.M: and the anode, the separator, and the cathode are wound to form an electrode assembly.**

149. Tanaka discloses or at least suggests that the anode, the separator, and the cathode are wound to form an electrode assembly, as discussed above regarding limitation [9.L]. *See above* § XII.A.14.

- G. Claim 16. The electronic device according to claim 15, wherein a first distance exists between the insulating layer and the first cathode active material layer in a longitudinal direction of the cathode current collector, a second distance exists between the insulating layer and the second cathode active material layer in**

**the longitudinal direction of the cathode current collector; and the first distance and the second distance are respectively greater than or equal to 0 and the second distance is less than or equal to the first distance.**

150. Tanaka discloses this claim limitation for the same reasons as those discussed above regarding claim 2. *See above* § XI.B.

**H. Claim 17. The electronic device according to claim 16, wherein the first distance and the second distance are disposed at a corner of the electrode assembly.**

151. Tanaka discloses this claim limitation for the same reasons as those discussed above regarding claim 11. *See above* § XII.C.

**I. Claim 18. The electronic device according to claim 16, wherein the first distance between the insulating layer and the first cathode active material layer in the longitudinal direction of the cathode current collector satisfies the following formula:  $0 \leq \text{the first distance} \leq \pi/4 D + 4 \text{ mm}$ ; and the second distance between the insulating layer and the second cathode active material layer in the longitudinal direction of the cathode current collector satisfies the following formula:  $0 \leq \text{the second distance} \leq \pi/4 D + 4 \text{ mm}$ .**

152. Tanaka discloses these claim limitations for the same reasons as those discussed above regarding claims 12 and 13. *See above* §§ XII.D and XII.E.

### **XIII. GROUND 1C: CLAIMS 8-13 AND 15-18 ARE OBVIOUS IN VIEW OF TANAKA AND YAMAFUKU**

#### **A. Obviousness Rationale**

153. A POSA would have been motivated to modify Tanaka's electrode structure to adopt a wound electrode assembly as explicitly taught by Yamafuku.

This is because doing so would have yielded predictable and well-known advantages in manufacturability, energy density, and mechanical robustness.

154. To start, Yamafuku and Tanaka are analogous to each other and to the problem of the '769 patent. The '769 patent is broadly directed towards “the field of electrochemical devices, and more particularly, to a cathode and a lithium-ion battery” that “adopts an active material layer in a two-layer structure” and “adjust[s] the gap between the active material layer and the insulating” to avoid “a failure caused by an internal short circuit” in the electrochemical device. EX1001 ('769 patent), 1:17-19, 1:45-57. Similarly, Tanaka describes the configuration of a cathode having multiple cathode active material layers and an insulating member in a lithium-ion secondary battery. EX1005 (Tanaka), [0001], [0031]. Likewise, Yamafuku describes the structure of a cathode used in a wound-type electrode assembly of a lithium-ion battery. EX1006 (Yamafuku), [0002], [0004], [0043], [0059].

155. Tanaka describes a lithium-ion secondary battery that includes a plurality of positive electrodes and a plurality of negative electrodes that are “alternately laminated with separator 20 interposed therebetween” to form an “electrode laminate body.” EX1005 (Tanaka), [0031]. Tanaka’s positive electrode includes a first active material layer 2a formed on a positive electrode current collector 3, and a second active material layer 2b formed on first active material

layer 2a. EX1005 (Tanaka), [0035]. An insulating member 40 is formed at a “border part” between the applied part where the first and second active material layers are formed and a non-applied part where no active material layer is deposited. EX1005 (Tanaka), [0036]. This cathode, and a corresponding anode, are “divided along cutting lines” and stacked with separator 20 to form the electrode laminate body. EX1005 (Tanaka), [0053]-[0054]. Thus, Tanaka discloses a laminated-type cathode structure.

156. However, Tanaka explicitly describes that its electrode structure is compatible with wound-type secondary batteries. EX1005 (Tanaka), [0003]. Tanaka even describes the method of forming a wound-type electrode by winding “a long positive electrode sheet and a long negative electrode sheet” “multiple times in a state of being overlapped with a separator interposed therebetween.” EX1005 (Tanaka), [0003]. Tanaka notes that, in each type of electrode structure, “[t]he positive electrode sheet and the negative electrode sheet each include an applied part where active material ... is applied on a current collector and a non-applied part where the active material is not applied for the connection with an electrode terminal,” and that, in each type of battery, “the battery electrode assembly is contained in a sealed outer container” with connections to the electrode terminals. EX1005 (Tanaka), [0003], [0004]. Thus, a POSA would understand that Tanaka’s multi-layer active material structure and insulating-

member architecture are not limited to laminated electrode configurations, but would be usable in wound electrode configurations to serve similar purposes, such as improving the performance and the safety feature of the lithium ion batteries.

157. Although Tanaka describes the configuration of and method of making a wound-type electrode in general terms, Tanaka does not provide specific details for manufacturing a wound-type electrode. However, because a wound-type electrode was well-known in the art as one of two main configurations (wound-type and laminated-type) that are used for different applications, *see* EX1005 (Tanaka), [0003]-[0004], a POSA would have been motivated to seek out additional references that provide more specific details of such a wound-type electrode for a lithium-ion battery. Yamafuku is such a reference.

158. Yamafuku teaches a wound-type electrode assembly that is formed of “a sheet-like positive electrode 3 and a sheet-like negative electrode 5 overlapped with positive electrode 3” with “a separator 4 arranged between” the two electrodes. EX1006 (Yamafuku), [0058]-[0059]. Unlike in Tanaka, where the cathode and anode are initially sheet-like but are cut to form sheets for laminating, Yamafuku’s wound-type electrode assembly merely winds the sheet-like electrodes (without cutting them) into an electrode assembly. EX1006 (Yamafuku), [0074], [0202]. A POSA would have understood, before the filing date of the ’769 patent, that such a wound-type electrode assembly may be more practical for use

“as a power source” for larger devices, such as “for a vehicle such as an automobile and a motorcycle, a variety of equipment such as a portable terminal and a notebook personal computer.” EX1006 (Yamafuku), [0003]. However, Yamafuku, much like Tanaka, notes the interchangeability of these two form factors, describing that its electrode assembly “is not limited to a winding type assembly, and for example, the electrode assembly may be a stacked type assembly prepared by stacking a plurality of positive electrodes and a plurality of negative electrodes.” EX1006 (Yamafuku), [0202]. Thus, a POSA would have known that Tanaka’s laminated-type electrode assembly could be modified in view of Yamafuku to create a wound-type electrode assembly.

159. And a POSA would not have experienced any unreasonable technical challenges in modifying Tanaka in view of Yamafuku. Tanaka and Yamafuku each apply similar cathode active materials onto a cathode current collector by mixing the active material into a solvent, which is subsequently evaporated from the cathode current collector. EX1005 (Tanaka), [0040], [0060]-[0061]; EX1006 (Yamafuku), [0098]-[0099], [0184]. Thus, the production methods employed by Tanaka (except for cutting the electrodes into laminate sheets) could readily be implemented to form the wound-type electrode of Yamafuku.

160. Modifying Tanaka in view of Yamafuku would have yielded the predictable result of a lithium-ion secondary battery having a wound-type electrode

assembly comprising a positive electrode and a negative electrode stacked together with a separator therebetween and wound into a prismatic or cylindrical form factor. A POSA would have recognized such a wound-type form factor as one of two well-known form factors for a lithium-ion secondary battery, EX1005 (Tanaka), [0003]; EX1006 (Yamafuku), [0202], where such a wound-type electrode assembly may be desirable for particular applications requiring a larger form factor battery, such as for a vehicle or a larger electronic device. EX1006 (Yamafuku), [0003]. Thus, a POSA would have found it obvious to modify Tanaka in view of Yamafuku to arrive at a wound-type electrode assembly.

**A. Claim 8**

161. Tanaka discloses claim 8 for the same reasons as those discussed above in Ground 1A. *See above* § XI.H.

162. In addition, Yamafuku teaches a similar electrode assembly having “an insulating layer arranged on the current collecting substrate.” EX1006 (Yamafuku), Abstract. Yamafuku’s insulating layer “contains an insulating material and a third binder.” EX1006 (Yamafuku), Abstract. The insulating material “include[s] inorganic particles and a resin,” where the inorganic particles may constitute “particles made from iron oxide, SiO<sub>2</sub>, Al<sub>2</sub>O<sub>3</sub>, TiO<sub>2</sub>, BaTiO<sub>2</sub>, ZrO, an alumina-silica composite oxide, and the like.” EX1006 (Yamafuku), [0127]-[0129]. Yamafuku’s third binder may be an aqueous binder formed of, for

example, “polyethylene oxide (polyethylene glycol), polypropylene oxide (polypropylene glycol), polyvinyl alcohol, polyacrylic acid, polymethacrylic acid, polytetrafluoroethylene (PTFE), a styrene butadiene rubber (SBR), polyolefin, a nitrile-butadiene rubber and cellulose, and more.” EX1006 (Yamafuku), [0067]. Thus, Yamafuku teaches using an insulating layer comprising *both* inorganic particles (e.g., “inorganic particles” of silicon oxide) *and* a polymer (e.g., polyethylene, polypropylene, etc.).

163. Yamafuku and Tanaka describe the use of similar materials for an insulating member. For example, Yamafuku teaches combining a polyolefin binder material with inorganic particles to create an insulating layer that is “excellent in insulation properties.” EX1006 (Yamafuku), [0011], [0210]. Similarly, Tanaka describes using a polyolefin (e.g., polypropylene) to form insulating member 40. EX1005 (Tanaka), [0048].

164. However, Tanaka also broadly describes that “polyimide, glass fiber, polyester, polypropylene, or materials containing them can be used.” EX1005 (Tanaka), [0048]. Thus, Tanaka explicitly invites a POSA to use other materials that comprise a polymer like polyethylene *as well as other components*, and a POSA would have looked to a reference such as Yamafuku to learn what kinds of other polymers and other components would be useful in this application.

165. Moreover, Yamafuku describes that, in these devices, “the electrodes are opposite to each other so that the respective active materials layers are adjacent to each other via a separator.” EX1006 (Yamafuku), [0006]. However, “the separator of the electrode assembly may shrink,” which may lead to a short circuit.” EX1006 (Yamafuku), [0007]. To avoid such a short circuit due to the separator, Yamafuku teaches enhancing “the insulation properties” of “an insulating layer on one electrode” of the electrode assembly. EX1006 (Yamafuku), [0008]-[0009]. Yamafuku achieves such enhanced “insulation properties” by incorporating inorganic particles into the insulating layer. *See, e.g.*, EX1006 (Yamafuku), [0049]. Thus, a POSA would have been motivated to modify Tanaka’s insulating member 40 to include the binder and inorganic particles taught by Yamafuku.

**B. Independent Claim 9**

**1. 9.P-9.K**

166. Tanaka discloses elements 9.P – 9.K for the same reasons as those discussed above in Ground 1B. *See above* § XII.A.

**2. 9.L: the anode, the separator, and the cathode are wound to form an electrode assembly.**

167. Tanaka discloses or at least suggests this claim limitation. *See above* § XII.A.14. To the extent Tanaka does not specify whether this embodiment can be arranged in a wound-type structure rather than a laminated structure, and Tanaka

does not provide any details for wound embodiments, a POSA would look to a reference like Yamafuku to learn whether and how Tanaka's laminated embodiment can be provided according to Tanaka's disclosure of a wound-type structure.

168. Yamafuku teaches “an energy storage device including an electrode assembly” that “includes a sheet-like positive electrode 3, a sheet-like negative electrode 5 and a sheet-like separator 4 arranged between the positive electrode 3 and the negative electrode 5.” EX1006 (Yamafuku), Abstract, [0075]. Yamafuku's electrode assembly is “formed in a belt-like shape” and is “wound to be used.” EX1006 (Yamafuku), Abstract, [0074].

169. Yamafuku explains that wound and stacked configurations are alternative implementations, and that a wound configuration may be desirable for particular applications requiring a larger form factor battery, such as for a vehicle or a larger electronic device. EX1006 (Yamafuku), [0003], [0202]. For these reasons, and for the reasons above in § XIII, a POSA would have found it obvious to modify Tanaka in view of Yamafuku to arrive at a wound-type electrode assembly.

**C. Claim 10.**

170. Tanaka discloses claim 10 for the same reasons as those discussed above in Ground 1B. *See above* § XII.B.

**D. Claim 11.**

171. Tanaka discloses claim 11 for the same reasons as those discussed above in Ground 1B. *See above* § XII.C.

**E. Claim 12.**

172. Tanaka discloses claim 12 for the same reasons as those discussed above in Ground 1B. *See above* § XII.D.

**F. Claim 13.**

173. Tanaka discloses claim 13 for the same reasons as those discussed above in Ground 1B. *See above* § XII.E.

**G. Independent Claim 15**

**1. 15.P-15.L**

174. Tanaka discloses elements 15.P – 15.L for the same reasons as those discussed above in Ground 1B. *See above* § XII.F.

**2. 15.M: the anode, the separator, and the cathode are wound to form an electrode assembly.**

175. Tanaka discloses or at least suggests this claim limitation for the same reasons as those discussed above. *See above* § XII.F.15. To the extent Tanaka does not specify whether this embodiment can be arranged in a wound-type structure rather than a laminated structure, and Tanaka does not provide any details for wound embodiments, Tanaka in view of Yamafuku renders obvious this claim limitation. *See above* § XIII.B.2.

**H. Claim 16.**

176. Tanaka discloses claim 16 for the same reasons as those discussed above in Ground 1B. *See above* § XII.G.

**I. Claim 17.**

177. Tanaka discloses claim 17 for the same reasons as those discussed above in Ground 1B. *See above* § XII.H.

**J. Claim 18.**

178. Tanaka discloses claim 18 for the same reasons as those discussed above in Ground 1B. *See above* § XII.I.

**XIV. GROUND 1D: CLAIMS 11 AND 17 ARE OBVIOUS IN VIEW OF TANAKA, YAMAFUKU, AND LI**

179. A POSA would have been motivated to modify the electrode assembly of Tanaka-Yamafuku further in view of Li. This is because Li identifies a particular problem with the wound electrode structure of Tanaka-Yamafuku and describes a specific solution to that problem.

180. To start, Li is analogous to each of Tanaka, Yamafuku, and the '769 patent. The '769 patent is broadly directed towards “the field of electrochemical devices, and more particularly, to a cathode and a lithium-ion battery” that “adopts an active material layer in a two-layer structure” and “adjust[s] the gap between the active material layer and the insulating” to avoid “a failure caused by an internal short circuit” in the electrochemical device. EX1001 ('769 patent), 1:17-19, 1:45-

57. Similarly, Tanaka describes the configuration of a cathode having multiple cathode active material layers and an insulating member in a lithium-ion secondary battery. EX1005 (Tanaka), [0001], [0031]. Likewise, Yamafuku describes the structure of a cathode used in a wound-type electrode assembly of a lithium-ion battery. EX1006 (Yamafuku), [0002], [0004], [0043], [0059]. And Li is directed towards “a prismatic lithium-ion battery having a winding structure” formed by winding “a positive electrode, a negative electrode, and a separator spaced between the positive electrode and the negative electrode. EX1009 (Li), [0051], [0008].

181. Tanaka-Yamafuku teaches a wound-type electrode assembly that is formed of “a sheet-like positive electrode 3 and a sheet-like negative electrode 5 overlapped with positive electrode 3” with “a separator 4 arranged between” the two electrodes. EX1006 (Yamafuku), [0058]-[0059]; see also EX1005 (Tanaka), [0003]-[0004]. As described above, a POSA would have recognized such a wound-type form factor as one of two well-known form factors for a lithium-ion secondary battery, EX1005 (Tanaka), [0003]; EX1006 (Yamafuku), [0202], where such a wound-type electrode assembly may be desirable for particular applications requiring a larger form factor battery, such as for a vehicle or a larger electronic device. EX1006 (Yamafuku), [0003]. Thus, a POSA would have found it obvious to modify Tanaka in view of Yamafuku to arrive at a wound-type electrode assembly.

182. Li, which published before each of Tanaka and Yamafuku, recognizes a specific problem with wound-type “prismatic” lithium-ion battery electrode assemblies. Specifically, Li describes that “compared with a battery having a stacked structure, the battery having a winding structure tends to deform during cycling,” such deformation being caused by “non-uniform stress distribution at different positions inside the battery, so that the battery tends to deform.” EX1009 (Li), [0003]. To avoid this deformation, Li teaches that “a ratio of the thickness of the positive electrode material layer in the corner region of the positive electrode to the thickness of the positive electrode material layer in the body region of the positive electrode is smaller than or equal to 90%.” EX1009 (Li), [0008]. Li also teaches that, while further reduction of deformation is possible by forming the corner region of the positive electrode as “a blank positive electrode current collector,” this also “tends to produce dendritic metal fragments” that may “puncture the separator and cause short circuit of the battery.” EX1009 (Li), [0016]-[0017]. For this reason, Li describes forming an insulating “protective layer” on the uncoated region of the positive electrode current collector. EX1009 (Li), [0017], FIG. 3.

183. Li’s “protective layer” that is formed on uncoated corner regions of the positive electrode current collector is analogous to Tanaka’s insulating member 40. For example, like Li’s protective layer, Tanaka’s insulating member 40 is

formed at the boundary between an applied part and a non-applied part on current collector 3. EX1009 (Li), [0017], FIG. 3; EX1005 (Tanaka), [0008], FIGS. 2, 10. In addition, like Li's protective layer 14, Tanaka's insulating member 40 may comprise an insulating resin such as, e.g., "polyimide." EX1009 (Li), [0021]; EX1005 (Tanaka), [0048]. And, in Li and Tanaka, the insulating layer may be formed by disposing a tape or adhesive layer directly on to the blank or non-applied region of the current collector. EX1009 (Li), [0018]; EX1005 (Tanaka), [0048]. Thus, a POSA would have understood that the teachings of Li's protective layer 14 would be directly applicable to Tanaka's insulating member 40.

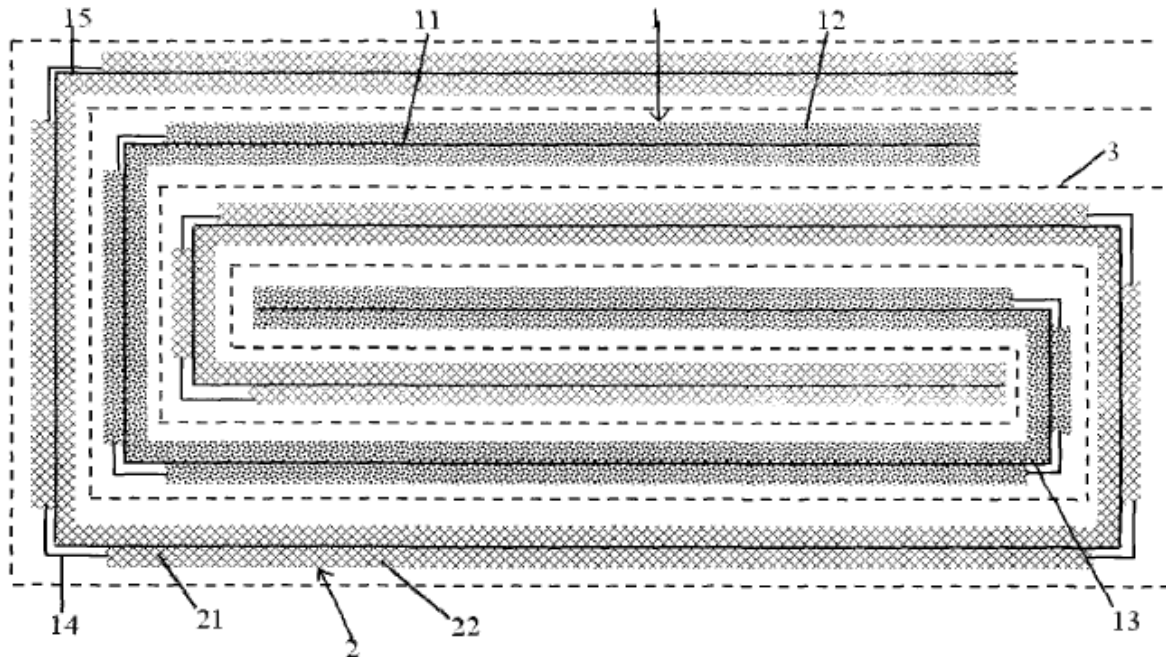
184. In the resulting combination of Tanaka-Yamafuku modified in further view of Li, Tanaka's insulating member 40 would be disposed on non-applied regions of the cathode collector that form the "corner" regions of the resulting electrode assembly. A POSA would have understood that this could be accomplished simply by adjusting the widths of Tanaka's applied regions and, instead of cutting the electrode into individual layers at cutting lines 90, simply winding the electrode to form corners at the cutting lines. A POSA also would have realized that the modification of Tanaka-Yamafuku further in view of Li would have predictably resulted in a wound-type electrode assembly that avoids both of the deformation and dendritic particle problems identified by Li years

earlier than the publication of either Tanaka or Yamafuku. EX1009 (Li), [0005], [0017].

**A. Claim 11: The electrochemical device according to claim 10, wherein the first distance and the second distance are disposed at a corner of the electrode assembly.**

185. Tanaka as modified in view of Yamafuku renders obvious this claim limitation for the same reasons as those discussed above. *See above* § XIII.D. To the extent Tanaka and Yamafuku do not explicitly describe forming the insulating layer (including the first distance and the second distance) at a corner of the electrode assembly, Li does.

186. In particular, Li describes “a lithium-ion battery having a winding structure, comprising a positive electrode, a negative electrode, a separator, and an electrolyte solution” that are wound into a prismatic cell. EX1009 (Li), Abstract, [0008]. An insulating protective layer 14 is formed in “the corner region[s] 13 of the positive electrode.” EX1009 (Li), [0017]-[0019], [0031], [0035], FIG. 3.



EX1009 (Li), FIG. 3.

187. Li teaches that the positioning of such an insulating protective layer avoids deformation caused by “non-uniform stress distribution” throughout the battery while also avoiding the formation of “dendritic metal fragments” in the cathode collector. EX1009 (Li), [0008]-[0009], [0016]-[0017]. Thus, a POSA would have been motivated to adjust the positioning of the insulating member in the winding-type electrode assembly of Tanaka-Yamafuku to be formed in the corners of the electrode assembly, as explicitly taught by Li to avoid deformation of the electrode assembly and formation of dendritic particles.

**B. Claim 17: The electronic device according to claim 16, wherein the first distance and the second distance are disposed at a corner of the electrode assembly.**

188. Tanaka as modified in view of Yamafuku renders obvious this claim limitation for the same reasons as those discussed above. *See above* § XIII.I. To the extent Tanaka and Yamafuku do not explicitly describe forming the insulating layer (including the first distance and the second distance) at a corner of the electrode assembly, Tanaka as modified in view of Yamafuku and further in view of Li renders obvious this claim limitation as those discussed above regarding claim 11. *See above* § XIV.A.

**XV. GROUND 1E: CLAIMS 14 AND 19 ARE OBVIOUS IN VIEW OF TANAKA, YAMAFUKU, AND KAPLAN**

189. A POSA would have been motivated to modify the electrode assembly of Tanaka-Yamafuku further in view of Kaplan. This is because Kaplan describes a wound electrode assembly formatted as a prismatic cell that is useful in a large number of electronic devices, including digital cameras and cell phones.

190. To start, Kaplan is analogous to each of Tanaka, Yamafuku, and the '769 patent. The '769 patent is broadly directed towards “the field of electrochemical devices, and more particularly, to a cathode and a lithium-ion battery” that “adopts an active material layer in a two-layer structure” and “adjust[s] the gap between the active material layer and the insulating” to avoid “a failure caused by an internal short circuit” in the electrochemical device. EX1001

(’769 patent), 1:17-19, 1:45-57. Similarly, Tanaka describes the configuration of a cathode having multiple cathode active material layers and an insulating member in a lithium-ion secondary battery. EX1005 (Tanaka), [0001], [0031]. Likewise, Yamafuku describes the structure of a cathode used in a wound-type electrode assembly of a lithium-ion battery. EX1006 (Yamafuku), [0002], [0004], [0043], [0059]. And Kaplan is directed towards “secondary lithium batteries, and in particular to lithium prismatic cells” that comprise “a prismatic-shaped housing that houses an anode, a cathode ... and a separator between the anode and the cathode” that are “wound” “to increase the surface area.” EX1010 (Kaplan), [0001], [0007], [0038].

191. Tanaka-Yamafuku teaches a wound-type electrode assembly that is formed of “a sheet-like positive electrode 3 and a sheet-like negative electrode 5 overlapped with positive electrode 3” with “a separator 4 arranged between” the two electrodes. EX1006 (Yamafuku), [0058]-[0059]; *see also* EX1005 (Tanaka), [0003]-[0004]. As described above, a POSA would have recognized such a wound-type form factor as one of two well-known form factors for a lithium-ion secondary battery, EX1005 (Tanaka), [0003]; EX1006 (Yamafuku), [0202], where such a wound-type electrode assembly may be desirable for particular applications requiring a larger form factor battery, such as for a vehicle or a larger electronic device. EX1006 (Yamafuku), [0003]. Thus, a POSA would have found it obvious

to modify Tanaka in view of Yamafuku to arrive at a wound-type electrode assembly.

192. Kaplan, which published before each of Tanaka and Yamafuku, describes a wound-type electrode assembly formed into a “prismatic cell” to make a battery that has “desirable properties for use in digital cameras and other applications.” EX1010 (Kaplan), [0007], [0038], FIG. 5. To begin, Kaplan describes, within the context of the prior art, that “[d]igital cameras and other electronic devices (for example, cell phones, MP3 players, and personal digital assistants (PDA’s) such as BlackBerries®) operate on batteries, such as ... secondary lithium ion batteries.” EX1010 (Kaplan), [0005]. Kaplan also describes that a “secondary, prismatic lithium ion” battery has been used “in digital cameras.” EX1010 (Kaplan), [0005]. Kaplan describes that such a “prismatic cell” “generally [has] a thickness that is much less than their width and length.” EX1010 (Kaplan), [0005].

193. Kaplan then goes on to describe an invention that “features prismatic cell type Li-ion secondary batteries” that “have desirable properties for use in digital cameras and other applications.” EX1010 (Kaplan), [0007]. Kaplan specifically defines such a “prismatic cell” as having “at least four generally flat sides, and [having] one dimension (e.g., thickness) that is substantially smaller than two other dimensions (e.g., length and width).” EX1010 (Kaplan), [0015]. Kaplan

describes that such a prismatic cell that is “desirable” “for use in digital cameras” and other electronic devices “can have a thickness of between about 2 mm and about 15 mm (e.g., between about 4 mm and about 10 mm).” EX1010 (Kaplan), [0015].

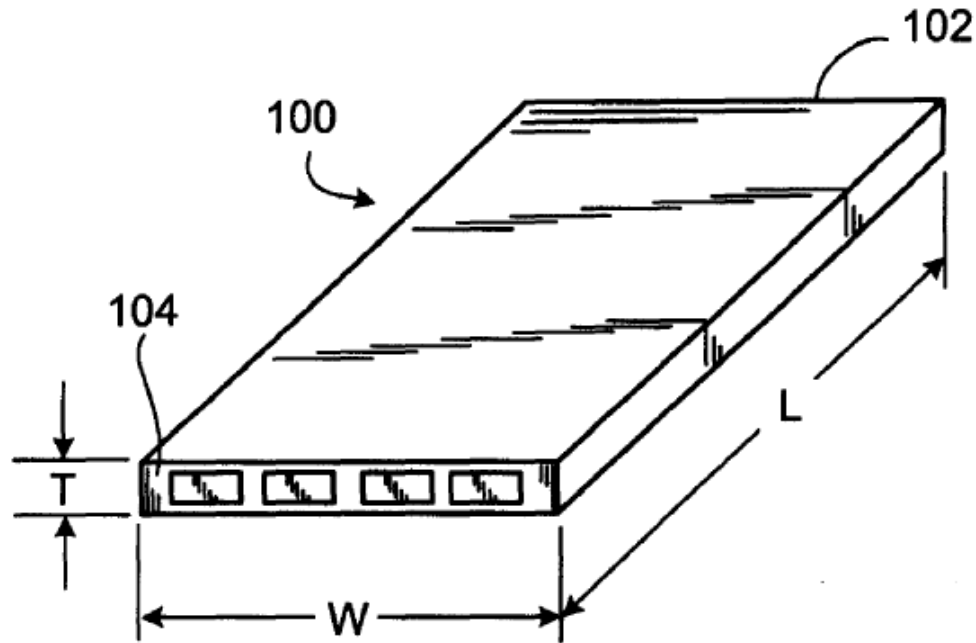
194. Kaplan’s “prismatic cell” is analogous to the wound-type electrode assembly of Tanaka-Yamafuku. For example, like Kaplan’s prismatic cell, the electrode assembly of Tanaka-Yamafuku is a wound-type electrode. EX1010 (Kaplan), [0038], FIG. 5; EX1005 (Tanaka), [0003]; EX1006 (Yamafuku), [0074], [0202], FIG. 7. Like Kaplan, the electrode assembly of Tanaka-Yamafuku is envisioned as being used to power, for example, “a portable apparatus such as a mobile phone, a digital camera and a laptop computer.” EX1005 (Tanaka), [0002]; *see also* EX1006 (Yamafuku), [0003] (e.g., “a portable terminal and a notebook personal computer”). And the electrode assembly of Tanaka-Yamafuku includes a cathode formed of an active lithium material, an anode formed of a carbon material, and a porous polymer separator. *Compare* EX1010 (Kaplan), [0007], [0039], [0040], *with* EX1005 (Tanaka), [0040], [0041], [0045]; EX1006 (Yamafuku), [0098]-[0099], [0146]. Thus, a POSA would have understood that the electrode assembly of Tanaka-Yamafuku could be configured into the “prismatic cell” form factor described in Kaplan.

195. In the resulting combination of Tanaka-Yamafuku modified in further view of Kaplan, the wound electrode assembly of Tanaka-Yamafuku would be configured to have “at least four generally flat sides” such that the thickness “is substantially smaller than two other dimensions (e.g., length and width).” EX1010 (Kaplan), [0015]. In particular, the electrode assembly of Tanaka-Yamafuku would be configured to “have a thickness of between about 2 mm and about 15 mm (e.g., between about 4 mm and about 10 mm),” as explicitly taught by Kaplan. EX1010 (Kaplan), [0015]. A POSA would have realized that forming the electrode assembly of Tanaka-Yamafuku into such a prismatic cell would enable the electrode assembly to be used in, for example, “digital cameras” as well as other electronic devices, including “cell phones, MP3 players, and personal digital assistants (PDA’s).” EX1010 (Kaplan), [0005], [0007]. Thus, a POSA would have been motivated to apply the electrode assembly of Tanaka-Yamafuku into a prismatic cell form factor, as described by Kaplan, for the predictable result of an electrode assembly that can be used in a large number of electronic devices, including digital cameras and cell phones. And to the extent that Kaplan, which published in 2009, may not have foreseen the impending ubiquity of cell phones, a POSA by the time of Tanaka and Yamafuku, which published in 2016 and 2015, respectively, certainly would have.

**A. Claim 14: The electrochemical device according to claim 9, wherein a thickness D of the electrode assembly is from about 1.5 mm to about 50 mm.**

196. To the extent Tanaka and Yamafuku do not explicitly describe an electrode assembly having a thickness D that is from about 1.5 mm to about 50 mm, Kaplan does.

197. Kaplan describes “a prismatic lithium ion” battery that may be used, for example, in “[d]igital cameras and other electronic devices (for example, cell phones, MP3 players, and personal digital assistants (PDA’s) such as BlackBerries®.” EX1010 (Kaplan), [0005]. Kaplan describes that, in this context, such a “prismatic lithium ion” battery should have “at least four generally flat sides, and [have] one dimension (e.g., thickness) that is substantially smaller than two other dimensions (e.g., length and width).” EX1010 (Kaplan), [0015]. In particular, Kaplan describes that “a prismatic cell can have a thickness of between about 2 mm and about 15 mm (e.g., between about 4 mm and about 10 mm).” EX1010 (Kaplan), [0015]. Kaplan’s prismatic cell battery “uses a wound electrode design” that is disposed in a housing having “a length L that is greater than its width W, and a thickness T that is substantially smaller than its length and width.” EX1010 (Kaplan), [0029], FIG. 1.



EX1010 (Kaplan), FIG. 1B.

198. Kaplan's "prismatic" wound-type electrode assembly is analogous to the wound-type electrode assembly of Tanaka in view of Yamafuku. Thus, a POSA would have been motivated to modify the wound-type electrode assembly of Tanaka in view of Yamafuku further in view of Kaplan to provide an electrode assembly with a form factor that could be used in a portable electronic device, such as a digital camera, cell phone, MP3 player, or PDA, as explicitly taught by Kaplan.

- B. Claim 19: The electronic device according to claim 15, wherein a thickness D of the electrode assembly is from about 1.5 mm to about 50 mm.**

199. To the extent Tanaka and Yamafuku do not explicitly describe an electrode assembly having a thickness D that is from about 1.5 mm to about 50

mm, Tanaka as modified in view of Yamafuku and further in view of Kaplan renders obvious this claim limitation for the same reasons as those discussed above regarding claim 14. *See above* § XV.A.

**XVI. GROUND 2A: CLAIMS 1-10, 12, 13, 15, 16, AND 18 ARE OBVIOUS IN VIEW OF KIM AND SIKHA**

**A. Obviousness Rationale**

200. Kim and Sikha are in the same field of endeavor as each other and the problem addressed by the '769 patent. The '769 patent is broadly directed towards “the field of electrochemical devices, and more particularly, to a cathode and a lithium-ion battery” that “adopts an active material layer in a two-layer structure” and “adjust[s] the gap between the active material layer and the insulating” to avoid “a failure caused by an internal short circuit” in the electrochemical device. EX1001 ('769 patent), 1:17-19, 1:45-57. Kim discloses “an electrode assembly and a secondary battery” that includes “an insulating member disposed on one side of the positive or negative electrode noncoating portion” to achieve “improve[d] efficiency and stability.” EX1007 (Kim), 1:14-19, 2:37-39. Likewise, Sikha describes “high-capacity energy storage devices” (e.g., “lithium-ion batteries”) that include “a multi-layer cathode structure” to create “faster charging, higher capacity energy storage devices that are smaller, lighter, and can be more cost effectively manufactured at a high production rate.” EX1008 (Sikha), [0002], [0009], [0010].

201. More specifically, Kim describes, for example, an “electrode assembly 10 [that] includes the positive electrode plate 20, the negative electrode plate 30, and the separator 40, which are stacked and wound in a jelly-roll type electrode assembly.” EX1007 (Kim), 3:50-53. Kim’s positive electrode plate 20 includes “a positive electrode coating portion 22” formed as a slurry on the surface of “positive electrode collector 21,” thereby defining a coating portion and “a positive electrode non-coating portion 23.” EX1007 (Kim), 3:58-65. An “insulating member 26 ... is adhered to the positive electrode noncoating portion 23” to be “adjacent to at least one of the ends of the positive electrode coating portion.” EX1007 (Kim), 4:37-40. Kim also describes that “the insulating member 26 may be formed to be spaced 3.5 mm or less apart from the end part of the positive electrode coating portion 22” and have a thickness of “about 24  $\mu$ m or more.” EX1007 (Kim), 6:50-52, 6:58-59.

202. Although Kim does not explicitly disclose that positive electrode coating portion 22 is formed to have a multi-layer structure, such a structure was well-known in the art prior to even the earliest possible filing of the ’769 patent. *See, e.g.*, EX1008 (Sikha), and also EX1005 (Tanaka), EX1011 (Wang), EX1014 (Brown) as evidence of obviousness of Kim and Sikha. And it was well known that a multi-layer cathode could combine higher power performance layers and lower voltage layers to achieve a “faster charging, higher capacity energy storage

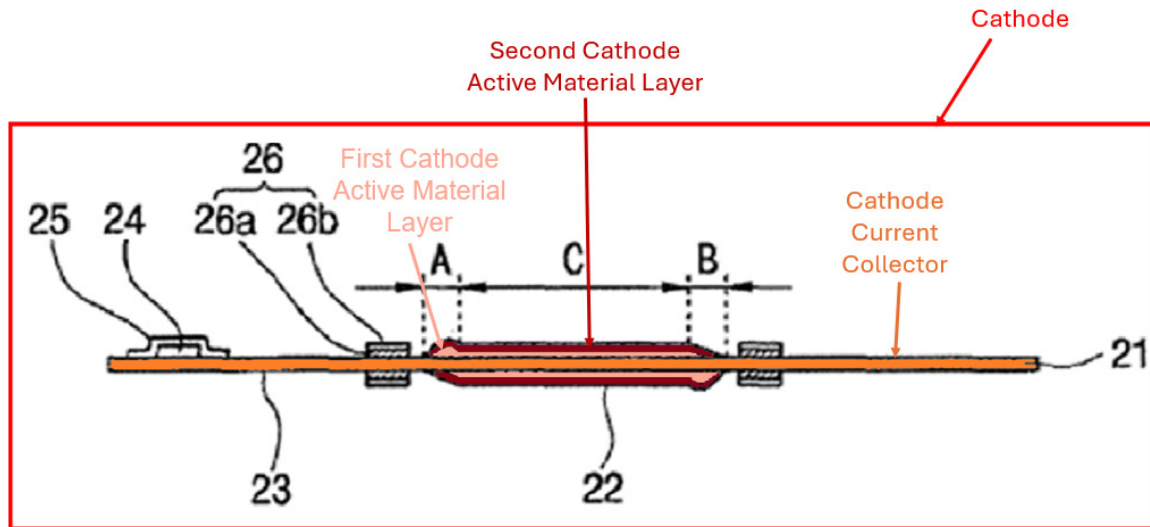
device.” EX1008, [0009]; *see also* corroborating evidence EX1011 (Wang), [0037]-[0038]; EX1014 (Brown), [0011]. Thus, a POSA would have sought references that explained how to provide such a multi-layer cathode structure in Kim’s electrode assembly. Sikha is such a reference.

203. Like Kim, Sikha describes a “cathode structure 103” for a lithium-ion battery that includes a first cathode material layer 210 formed over currently collector 113. EX1008 (Sikha), [0034], [0038]. Like in Kim, Sikha’s cathode material layer may be formed by applying a “slurry mixture comprising a cathodically active material” “on current collector 113.” EX1008 (Sikha), [0038]; EX1007 (Kim), 6:11-20. However, Sikha then describes “form[ing] a second cathode material layer 220” “on the first cathode material layer 210” by depositing “a second slurry mixture.” EX1008 (Sikha), [0053]. This second cathode material layer 220 may, like the first cathode material layer 210 below it, “comprise cathodically active materials and at least one of a binder, electro-conductive material and a solvent.” EX1008 (Sikha), [0053]. Sikha describes that the first and second cathode material layers may vary from one another in terms of porosity, choice of cathodically active material, average particle size, tap density, and average thickness. EX1008 (Sikha), [0059], [0061], [0063], [0064], [0067], [0068]. The two active material layers may then be “compressed to achieve a desired porosity.” EX1008 (Sikha), [0060].

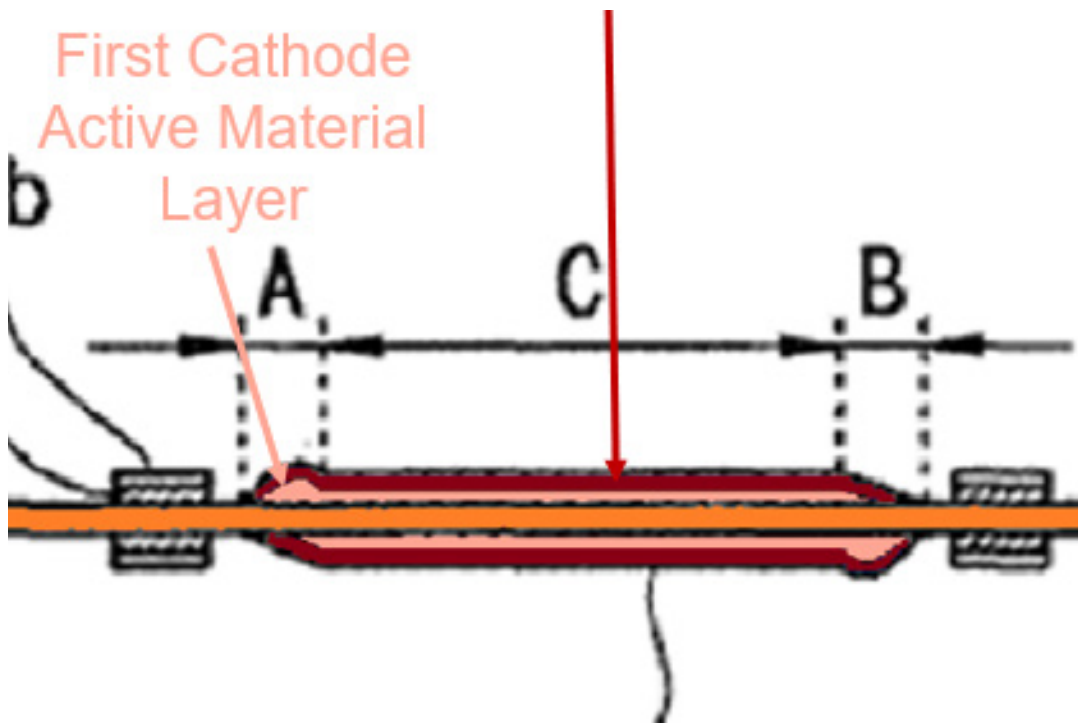
204. Sikha also describes specific advantages that result from using a multi-layer cathode structure instead of a single-layer cathode structure. First, Sikha describes that multi-layer cathode designs enable thicker/denser electrodes and can increase the battery energy density and reduce production cost while addressing shortcomings of conventional thicker-electrode processes (e.g., lack of adhesion/cohesion and cycling fatigue). EX1008 (Sikha), [0008]. Second, Sikha describes that such multi-layer cathode structures address “a need in the art for faster charging, higher capacity energy storage devices that are smaller, lighter, and can be more cost effectively manufactured at a high production rate.” EX1008 (Sikha), [0009]. Third, Sikha describes that layering electrodes with different properties/material choices is expected to yield improved performance (e.g., higher power and longer cycle) relative to uniform single-layer electrodes. EX1008 (Sikha), [0024]. A POSA would have realized that these benefits could readily be realized in Kim’s electrode assembly simply by modifying Kim’s cathode structure to incorporate two cathode active material layers, as taught by Sikha.

205. And a POSA would have known that modifying Kim in view of Sikha would have involved only the routine application of known slurry deposition methods to form Sikha’s first and second cathode active layers on Kim’s current collector. This is because Sikha describes using a slurry-based deposition technique similar to that disclosed by Kim to form each of the cathode active

material layers. EX1008 (Sikha), [0039], [0053]; EX1007 (Kim), 6:7-24. The results of this combination are depicted in the below annotated Figure 2B of Kim:



EX1007 (Kim), FIG. 2B (annotated to show cathode layers taught by Sikha).



EX1007 (Kim), FIG. 2B (annotated as above to show cathode layers taught by Sikha, abridged and enlarged).

206. Given the similarity of the techniques described by Kim and Sikha, a POSA would not have encountered any unreasonable technical challenges in modifying Kim to include a multi-layer cathode structure taught by Sikha.

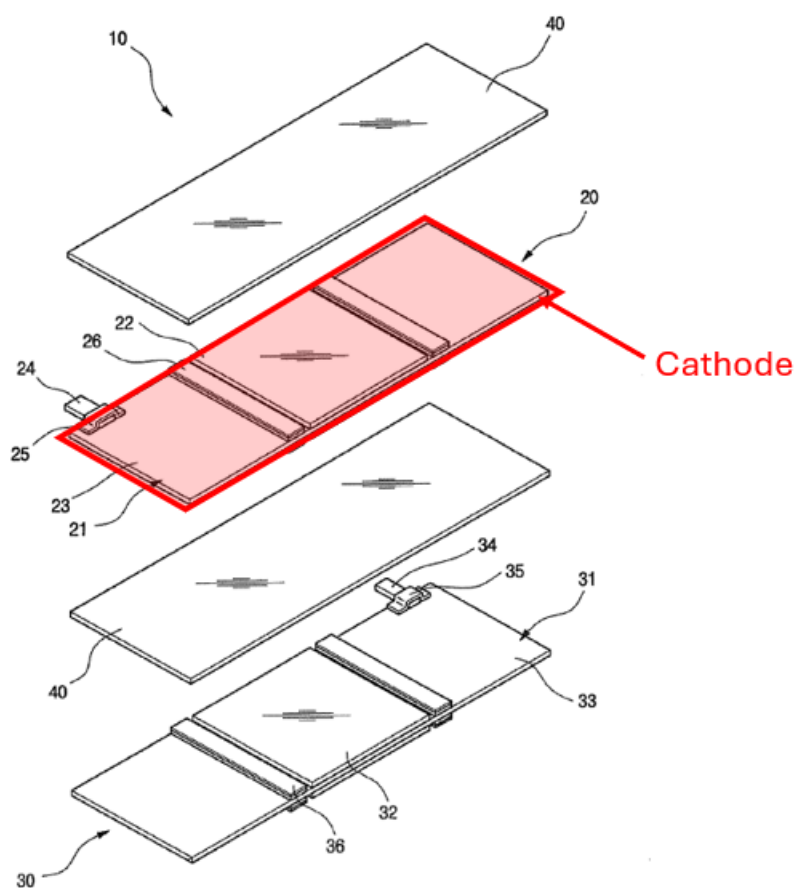
207. Modifying Kim in view of Sikha would have yielded the predictable result of a cathode structure for a lithium-ion battery having a second cathode active material layer disposed on a first cathode active material layer. A POSA would have known that such a multi-layer cathode structure would result in “faster charging,” “higher capacity,” “higher power,” and “longer cycle” lithium-ion batteries “that are smaller, lighter, and can be more cost effectively manufactured at a high production rate” than cathode single-layer lithium-ion batteries. EX1008 (Sikha), [0009], [0024]. Thus, a POSA would have found it obvious to modify Kim in view of Sikha to arrive at the claimed multi-layer cathode structure.

**B. Independent Claim 1**

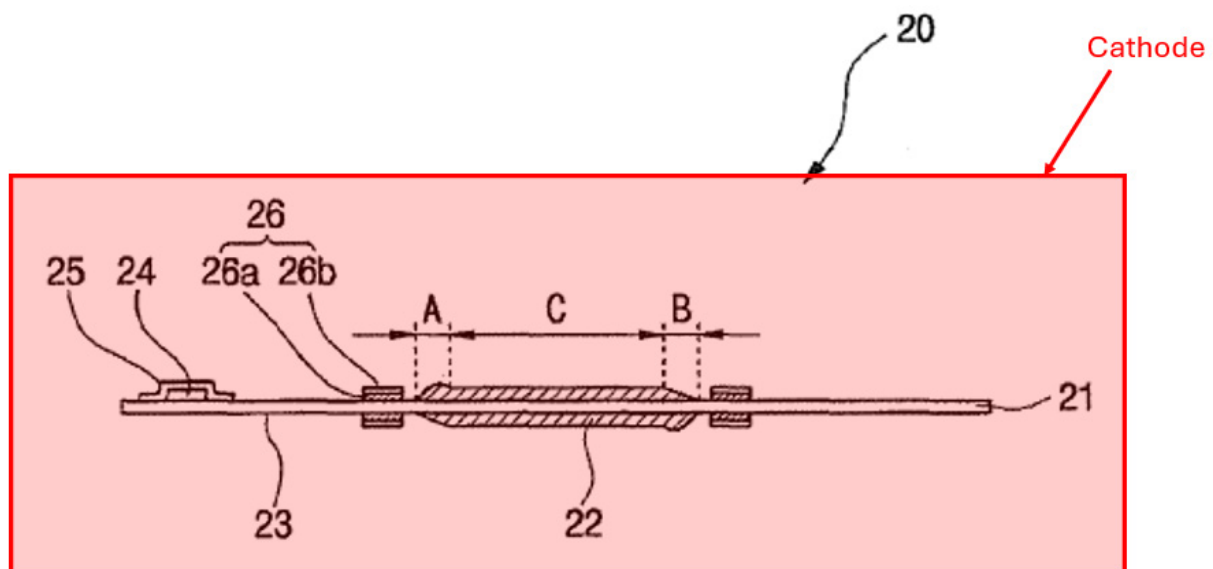
**1. 1.P: A cathode, comprising:**

208. Kim discloses “an electrode assembly 10 includes a first electrode plate (hereinafter, referred to as a positive electrode plate) 20.” EX1007 (Kim), 3:50-57; *see also* EX1007 (Kim), Abstract, 2:29-45, 5:65-6:6, 6:7-11, FIGS. 1 and 2B. Kim’s positive electrode is the same as the “cathode” recited in limitation 1.P.

FIG. 1



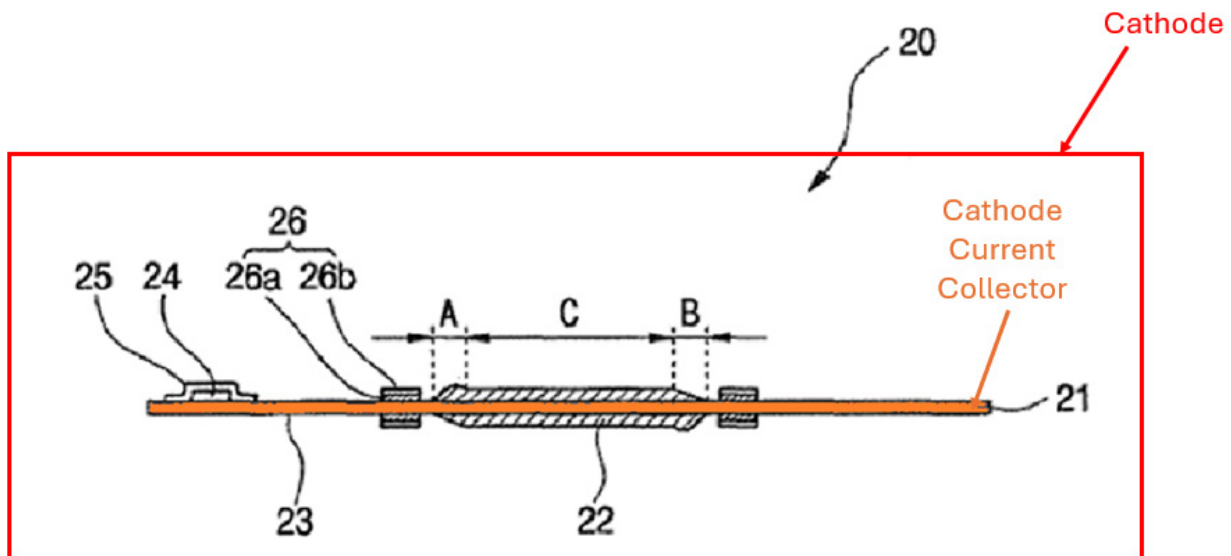
EX1007 (Kim), FIG. 1 (annotated).



EX1007 (Kim), FIG. 2B (annotated).

**2. 1.A: a cathode current collector, having a first surface;**

209. Kim discloses that positive electrode plate 20 includes “a positive electrode collector” that may “be formed of stainless steel, nickel, aluminum, titanium or an alloy thereof, or aluminum or stainless steel whose surface is treated with carbon, nickel titanium, or silver” and “is generally formed to a thickness of 1 to 50  $\mu\text{m}$ , and preferably 1 to 30  $\mu\text{m}$ .” EX1007 (Kim), 2:29-45, 4:3-14, FIG. 2B. Kim’s positive electrode collector 21 is the same as the recited cathode current collector of limitation 1.1.

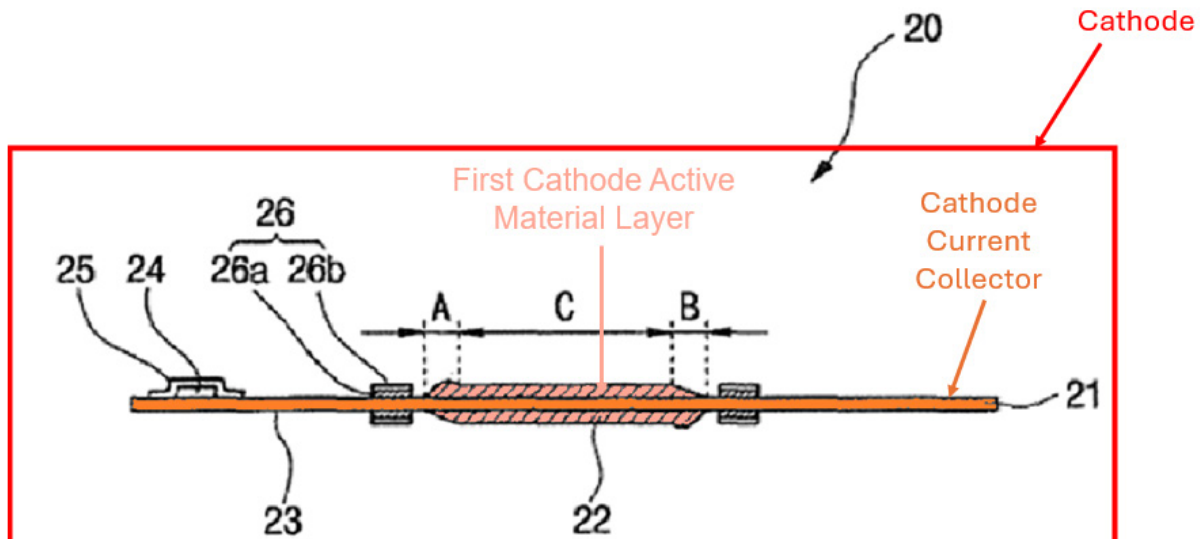


EX1007 (Kim), FIG. 2B (annotated).

**3. 1.B: a first cathode active material layer, comprising a first cathode active material;**

210. Kim discloses that a portion of positive electrode collector 21 is coated with a material to form a positive electrode coating portion 22. EX1007

(Kim), 2:29-45, 3:50-57, 5:65-6:6, 6:7-11; FIG. 2B. The material provided in Kim's positive electrode coating portion 22 may include a "positive electrode active material" such as "at least one of a complex oxide and lithium." EX1007 (Kim), 4:15-28. Thus, the active material disposed within Kim's positive electrode coating portion 22 is the same as the claimed first cathode active material layer comprising a first cathode active material that is recited by limitation 1.B.



EX1007 (Kim), FIG. 2B (annotated).

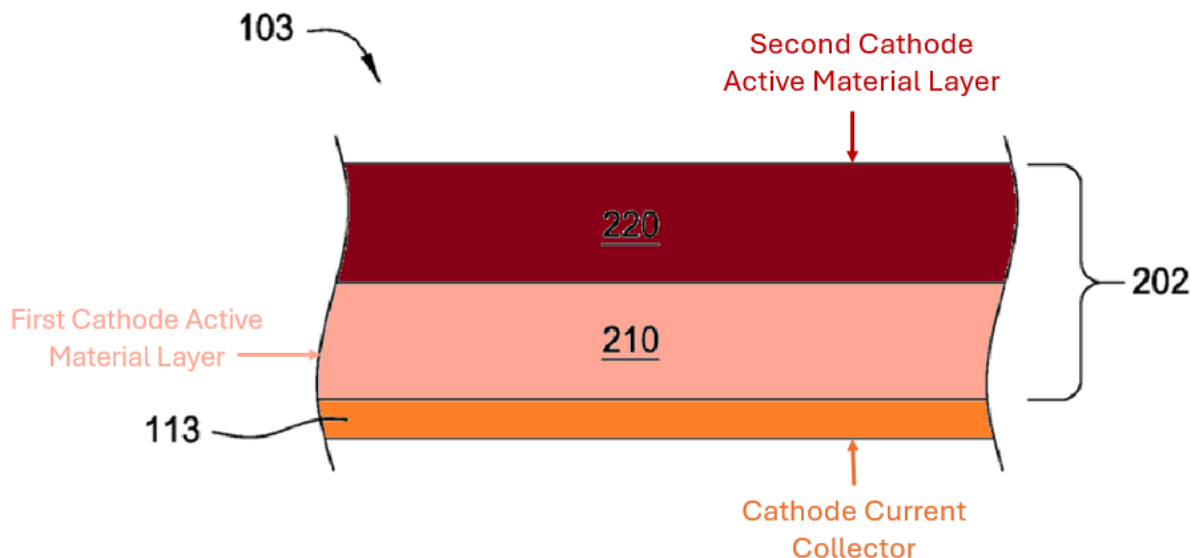
**4. 1.C: a second cathode active material layer, comprising a second cathode active material;**

211. Kim in view of Sikha teaches a second cathode active material layer comprising a second cathode active material.

212. If Kim is alleged to lack this feature, Sikha teaches "a method for forming a multi-layer cathode structure." EX1008 (Sikha), Abstract, [0010].

Sikha's method comprises "depositing a first slurry mixture comprising a

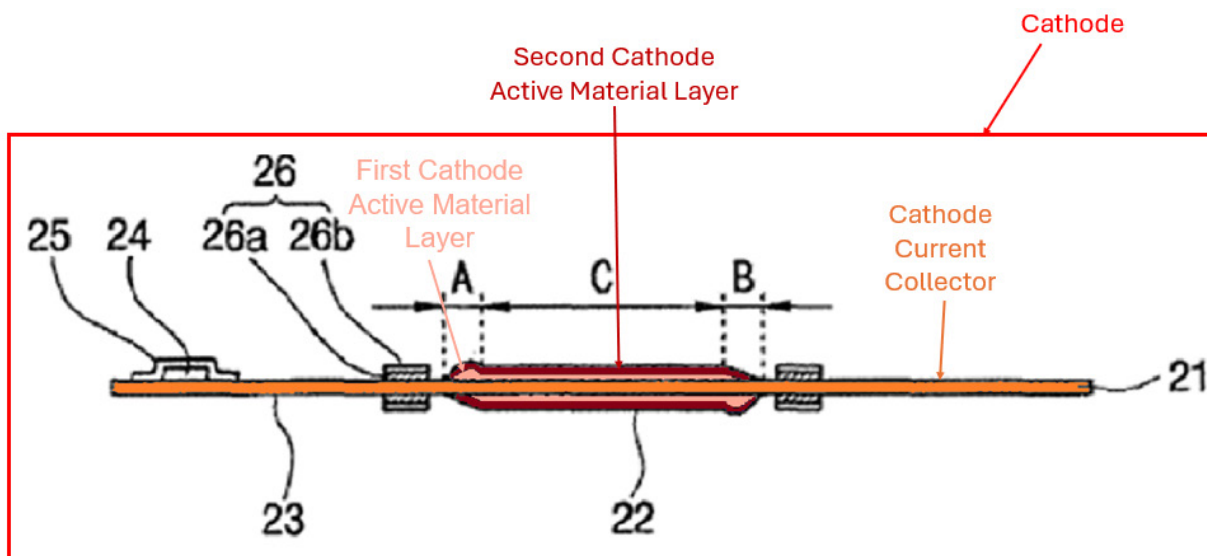
cathodically active material to form a first cathode material layer over [a] conductive substrate.” EX1008 (Sikha), Abstract, [0010]; *see also* EX1008 (Sikha), [0038]. Then, a “second slurry mixture comprising a cathodically active material” is deposited “over the first cathode material layer” “to form a second cathode material layer.” EX1008 (Sikha), Abstract, [0010]; *see also* EX1008 (Sikha), [0053]. Sikha teaches that, to form the “active electrode material of a Li-ion battery,” “a wide range of lithium transition metal oxides” may be used, such as, for example, “ $\text{LiMn}_2\text{O}_4$  (LMO),” “layered structures ( $\text{LiCoO}_2$ , lithium nickel-manganese-cobalt oxides (NMC))” and “ $\text{LiFePO}_4$ .” EX1008 (Sikha), [0006]. The result is the formation of a multi-layer cathode structure having a second cathode active layer formed on top of a first cathode active layer. *See* EX1008 (Sikha), [0010], [0034], FIG. 2C.



EX1008 (Sikha), FIG. 2C (annotated).

213. The combination of Kim in view of Sikha teaches this claim element.

214. In particular, as described above, it would have been obvious to a POSA prior to the earliest possible filing date of the '769 patent, to modify Kim in view of Sikha to provide the multi-layer cathode structure shown below. *See above* § XV.A.



EX1007 (Kim), FIG. 2B (annotated to show cathode layers taught by Sikha).

215. Like the '769 patent, Kim and Sikha are each directed towards electrode structures, particularly to cathode electrode structures, for lithium-ion secondary batteries. EX1001 ('769 patent), 1:17-19; EX1007 (Kim), 1:14-19, 2:29-41; EX1008 (Sikha), [0002]; *see above* § XVI.A.

216. In addition, a POSA would have known that Sikha's multi-layer cathode structure could be readily applied to Kim's electrode assembly. *See above* § XVI.A. This is because, like Kim, Sikha describes using a cathode current

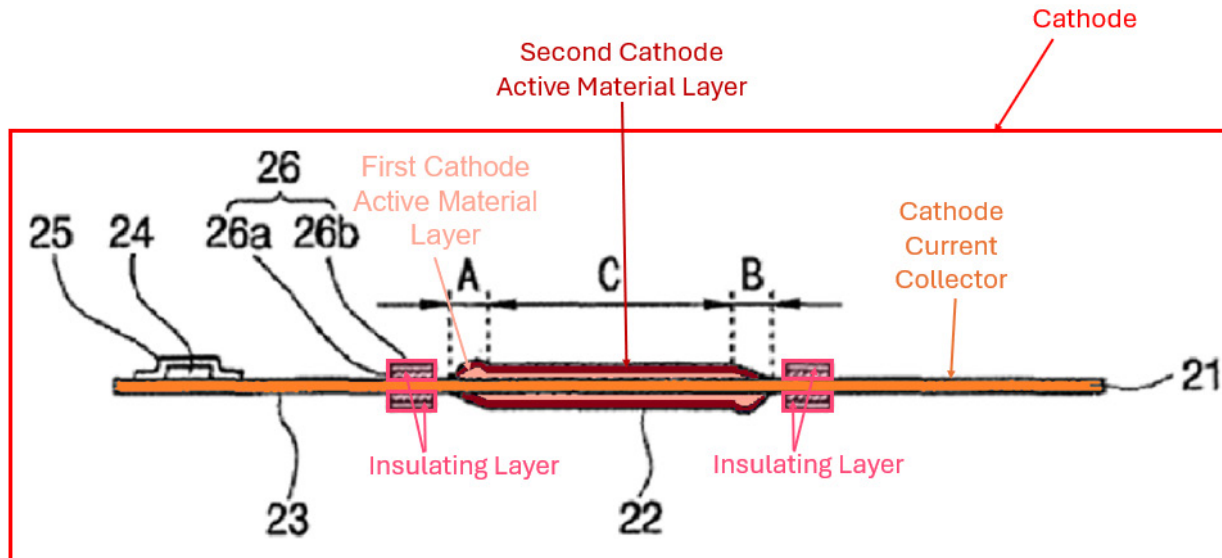
collector formed of, for example, “a conductive substrate (e.g., metallic foil, sheet, or plate)” made of one or more of “aluminum (Al), copper (Cu), zinc (Zn), nickel (Ni), cobalt (Co), tin (Sn), manganese (Mn), magnesium (Mg), alloys thereof, and combinations thereof.” *Compare* EX1008 (Sikha), [0035] *with* EX1007 (Kim), 4:3-6. Sikha, like Kim, describes applying a “slurry mixture comprising a cathodically active material” “on the current collector 113.” *Compare* EX1008 (Sikha), [0038] *with* EX1007 (Kim), 6:11-20. Sikha then repeats this slurry deposition step to form “a second cathode material layer 220” “on the first cathode material layer 210.” EX1008 (Sikha), [0053]. Thus, Sikha’s multi-layer cathode structure comprises similar materials and deposition processes to those already disclosed by Kim. Additionally, Sikha discloses detailed procedures for applying the multi-layer cathode on the same current collectors used by Kim. *Compare* EX1008 (Sikha), [0035], [0038] *with* EX1007 (Kim), 4:3-6, 6:11-20. Thus, a POSA would have understood that there is no technical barrier to adopting Sikha’s multi-layer cathode structure in manufacturing the lithium-ion batteries disclosed by Kim. Accordingly, modifying Kim in view of Sikha would have involved only the routine application of known slurry deposition methods, as taught by each of Kim and Sikha, and thus would not have presented any unreasonable technical challenges.

217. And a POSA would have realized that Sikha's multi-layer cathode structure would have resulted in thicker and denser electrodes with faster charging and higher capacity, power, and efficiency, as compared to Kim's single-layer cathode structure. *See above* § XVI.A; *see also* EX1008 (Sikha), [0008]-[0009], [0024]. And a POSA would have understood that these benefits could be realized simply by substituting Sikha's multi-layer cathode structure in place of Kim's positive electrode coating portion. *See above* § XVI.A.

218. For all of the above reasons, a POSA would have found it obvious to modify Kim in view of Sikha to include a multi-layer cathode structure.

**5. 1.D: an insulating layer, wherein**

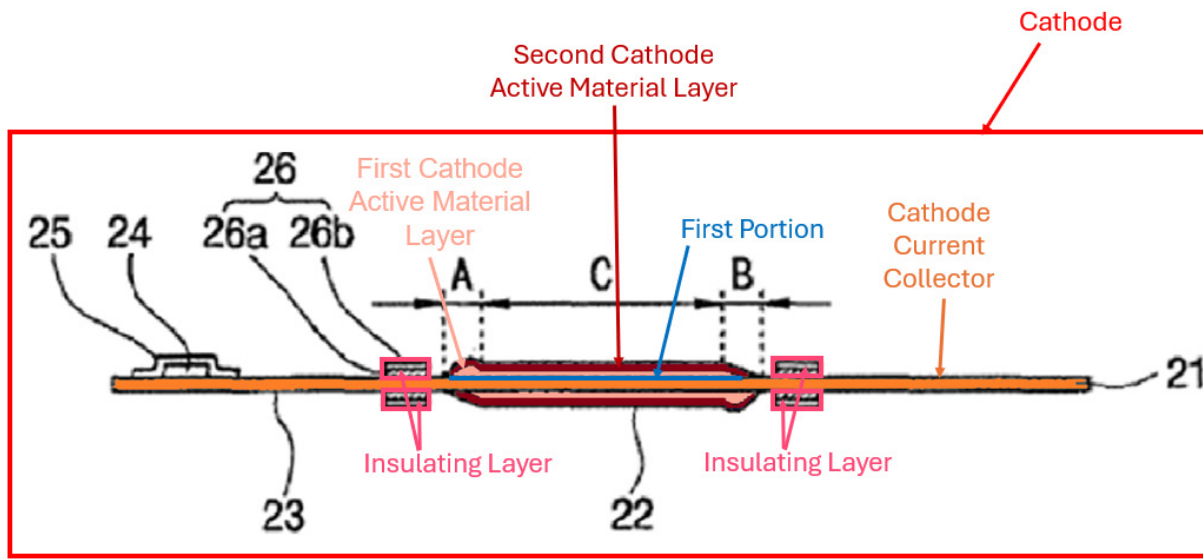
219. Kim discloses that "an insulating member" may be "disposed on one side of the positive or negative electrode non-coating portion. EX1007 (Kim), 2:29-45; *see also* EX1007 (Kim), 4:37-50 ("positive electrode plate 20 also includes an insulating member 26"). Kim's insulating member 26 is the same as the insulating layer recited by limitation 1.D.



EX1007 (Kim), FIG. 2B (annotated to show cathode layers taught by Sikha).

6. **1.E: the first cathode active material layer is disposed between the cathode current collector and the second cathode active material layer and covers a first portion of the first surface of the cathode current collector, and**

220. The combination of Kim in view of Sikha teaches this claim element. In particular, the result of modifying Kim in view of Sikha to include two cathode active layers, as discussed above, would be a first cathode active material layer disposed on (and thus covering a portion of) Kim's current collector 21, and a second cathode active material layer disposed over the first cathode active material layer, which is the structure explicitly taught by Sikha. The results of the combination of Kim-Sikha are depicted in the below annotated Figure 2B of Kim:



EX1007 (Kim), FIG. 2B (annotated to show cathode layers taught by Sikha).

221. Because this claim limitation is merely the result of modifying Kim in view of Sikha to provide Kim's cathode with a multi-layer cathode structure, as discussed above, it would have been obvious to modify Kim in view of Sikha to arrive at this claim limitation for the same reasons as those discussed above. *See above* §§ XVI.A, XVI.B.4.

**7. 1.F: the insulating layer covers a second portion of the first surface of the cathode current collector that is different from the first portion,**

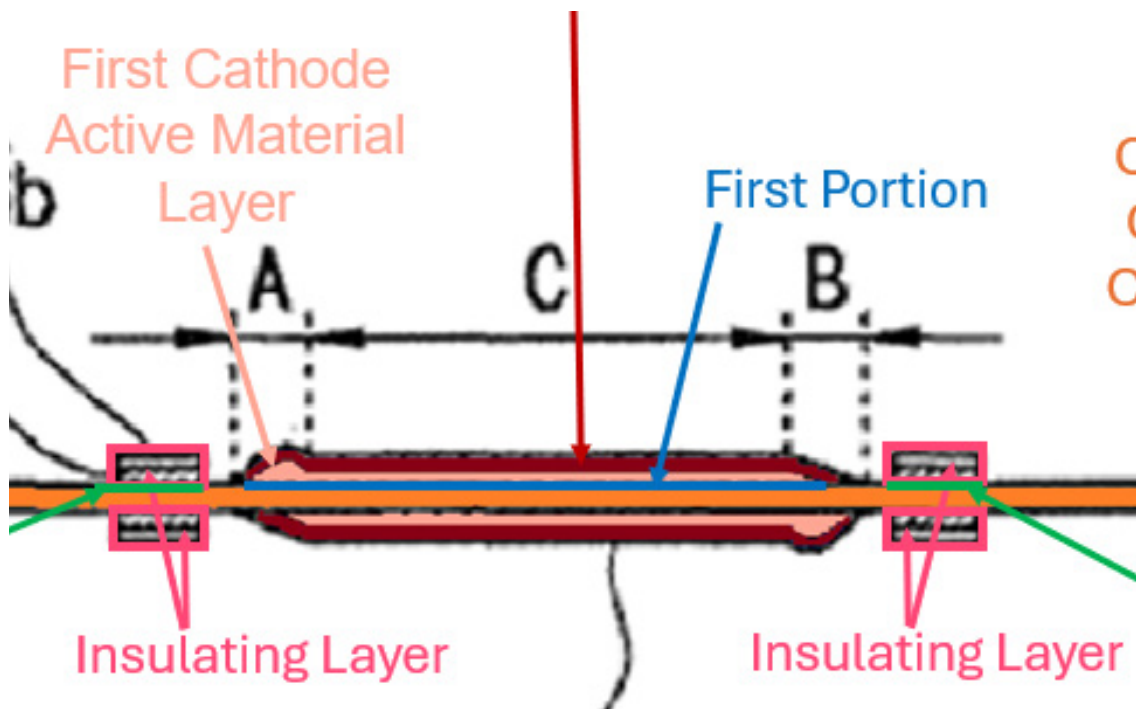
222. Kim discloses that positive electrode collector 21 includes a non-coating portion 23 that is not coated by the positive electrode active material but is covered by insulating member 26. EX1007 (Kim), 3:58-4:2. In particular, Kim's insulating member 26 is "adhered to the positive electrode non-coating portion 23



**8. 1.G: wherein a thickness of the insulating layer is greater than a thickness of the first cathode active material layer.**

223. The combination of Kim in view of Sikha teaches this claim element.

*See above* §§ XVI.A, XVI.B.4. In particular, the result of modifying Kim in view of Sikha to include two cathode active layers, as discussed above, would be a first cathode active material layer disposed on (and thus covering a portion of) Kim's current collector 21, and a second cathode active material layer disposed over the first cathode active material layer, which is the structure explicitly taught by Sikha, as shown in the below annotated Figure 2B of Kim:



EX1007 (Kim), FIG. 2B (annotated, abridged, and enlarged as above).

224. The above combination of Kim and Sikha teaches this claim element in at least two different ways.

225. First, Kim describes that insulating member 26 may have a thickness that is “equal to” the thickness of positive electrode coating portion 22. EX1007 (Kim), 6:58-7:13. In the proposed combination of Kim in view of Sikha, positive electrode coating portion 22 would be *replaced* with Sikha’s first cathode material layer 210 and second cathode material layer 220. In this case, because at least some of the total thickness of the combined cathode material layer 210 and 220 is due to the thickness of second cathode material layer 220, the thickness of the first cathode material layer 210 would *implicitly* be less than the thickness of Kim’s insulating member 26. Thus, the proposed modification of Kim in view of Sikha teaches this claim element.

226. Alternatively, a POSA would arrive at this claim element by straightforward application of the layer thicknesses taught by Kim and Sikha. For example, Kim describes that insulating member 26 should have a thickness that is “about 24  $\mu\text{m}$  or more, so that the insulating member 26 can prevent damage from the non-uniform regions A and B and be capable of insulating.” EX1007 (Kim), 6:58-61. Kim also establishes an upper end of the range for the thickness of insulating member 26 as being “equal to or less than the thickness of the positive electrode coating portion 22,” to thereby avoid increasing the thickness of the electrode assembly. EX1007 (Kim), 6:61-65. Regarding the first cathode material layer 210, Sikha describes that “the first cathode material layer 210 has a thickness

between about 10  $\mu\text{m}$  to about 150  $\mu\text{m}$ ,” and describes a specific example of a cathode structure in which the first cathode material layer “may have an average thickness from about 1 to 80 microns.” EX1008 (Sikha), [0038], [0068]. In isolation, these two disclosures alone suggest that insulating member 26 may be formed to have a thickness that is, at least in some cases, larger than the thickness of first cathode material layer 210. However, Sikha also describes that second cathode material layer 220 “may have a thickness from about 10 to 80 microns.” EX1008 (Sikha), [0068]. Taken altogether, a POSA would understand that, in the combination of Kim-Sikha, insulating member 26 could be formed to have a thickness of, for example, 160  $\mu\text{m}$  (equal to the thickness of first cathode material layer 210 of 80  $\mu\text{m}$  plus the thickness of second cathode material layer 220 of 80  $\mu\text{m}$ ) while still not increasing the thickness of the electrode assembly. Accordingly, the proposed modification of Kim in view of Sikha renders obvious this claim element for this reason as well.

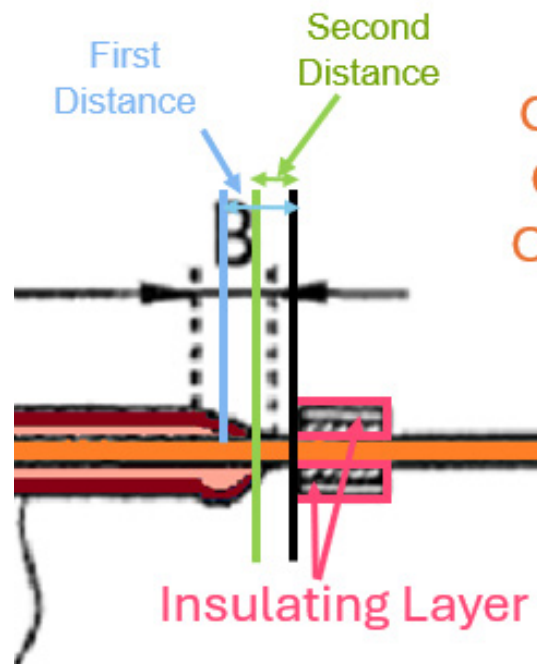
227. Moreover, Kim in view of Sikha explicitly motivates at least one combination that would clearly satisfy this claim element. For example, Sikha explains that “the thickness ratio of the first cathode material layer 210 to the second cathode material layer 220 is between about 5:1 to 1:5.” EX1008 (Sikha), [0068]. Applying the endpoint ratio of 1:5 to Sikha’s teaching that second cathode material layer 220 should have a maximum thickness of 80  $\mu\text{m}$  would imply that

the first cathode material layer 210 would have a thickness of only 16  $\mu\text{m}$  (that is, 1/5 of 80  $\mu\text{m}$ ), which is less than the minimum thickness for Kim's insulating member 26 of 24  $\mu\text{m}$ . EX1007 (Kim), 6:58-61. Thus again, this element is satisfied by the above modification of Kim in view of Sikha. *See above* §§ XVI.A, XVI.B.4.

**C. Claim 2. The cathode according to claim 1, wherein a first distance exists between the insulating layer and the first cathode active material layer in a longitudinal direction of the cathode current collector, a second distance exists between the insulating layer and the second cathode active material layer in the longitudinal direction of the cathode current collector; and the first distance and the second distance are respectively greater than or equal to 0 and the second distance is less than or equal to the first distance.**

228. The combination of Kim in view of Sikha teaches this claim element. *See above* §§ XVI.A, XVI.B.4. Specifically, Kim discloses that an “insulating member 26 may be formed adjacent to at least one of the ends of the electrode coating portion 22,” such that “a distance” is provided “between the insulating member 26 and the positive electrode coating portion 22.” EX1007 (Kim), 6:25-57. Kim discloses that, based on several physical limitations, “the insulating member 26 may be formed to be spaced 3.5 mm or less apart from the end part of the positive electrode coating portion 22.” EX1007 (Kim), 6:50-52. The above combination of Kim and Sikha teaches this claim element. In particular, in the resulting combination of Kim as modified in view of Sikha, there would be a distance between insulating member 26 and each of first cathode active material

layer 210 (the claimed “first distance”) and second cathode active material layer 220 (the claimed “second distance”), as explicitly taught by Kim. EX1007 (Kim), 6:25-57. Each of these distances would be greater than zero and less than or equal to 3.5 mm, as described by Kim. EX1007 (Kim), 6:46-52. And, because the second cathode active material layer extends beyond the first cathode active material layer, the second distance is necessarily less than the first distance, as shown below. Thus, the above combination of Kim in view of Sikha renders obvious this claim limitation. *See above* §§ XVI.A, XVI.B.4.



EX1007 (Kim), FIG. 2B (annotated, abridged, and enlarged).

**D. Claim 3. The cathode according to claim 2, wherein the first distance is from about 0 mm to about 83 mm.**

229. The combination of Kim in view of Sikha teaches this claim element.

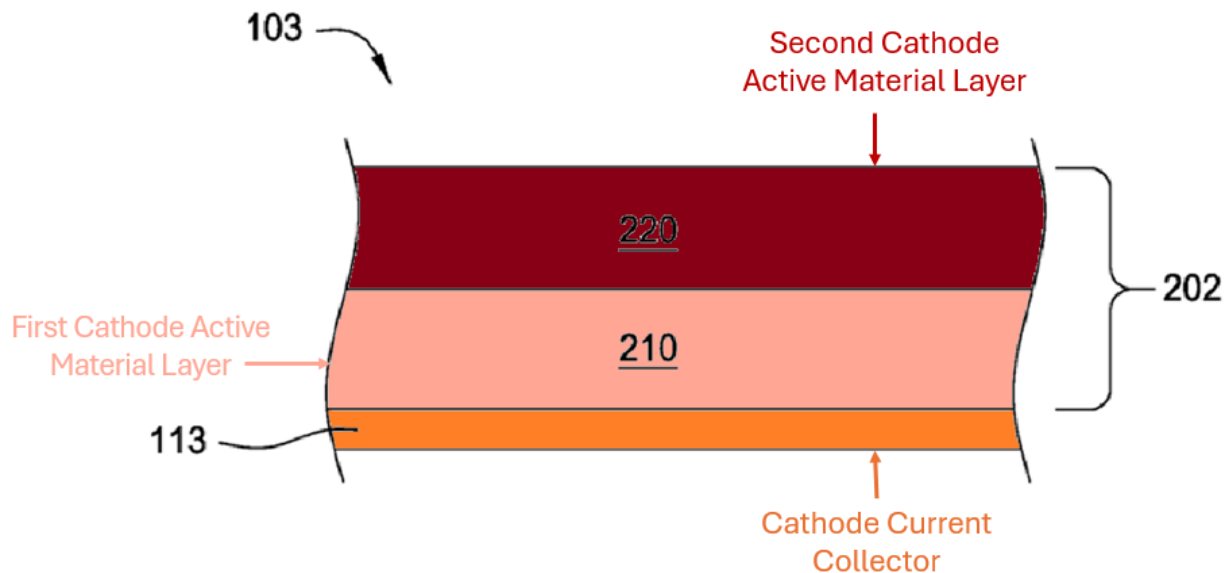
*See above* §§ XVI.A, XVI.B.4. Specifically, Kim discloses that an “insulating

member 26 may be formed adjacent to at least one of the ends of the electrode coating portion 22,” such that “a distance” is provided “between the insulating member 26 and the positive electrode coating portion 22.” EX1007 (Kim), 6:25-57. In view of several limitations, Kim discloses that “the insulating member 26 may be formed to be spaced 3.5 mm or less apart from the end part of the positive electrode coating portion 22.” EX1007 (Kim), 6:50-52.

230. The above combination of Kim and Sikha teaches this claim element. In particular, in the resulting combination of Kim as modified in view of Sikha, there would be a distance between insulating member 26 and each of first cathode active material layer 210 (the claimed “first distance”) and second cathode active material layer 220 (the claimed “second distance”), as explicitly taught by Kim. 6:25-57. The distance between insulating member 26 and first cathode active material layer 210 would be greater than zero and less than or equal to 3.5 mm, as described by Kim. EX1007 (Kim), 6:46-52. This range overlaps the range of from about 0 mm to about 83 mm recited by claim 3. Thus, the above combination of Kim in view of Sikha renders obvious this claim limitation. *See above* §§ XVI.A, XVI.B.4.

**E. Claim 4. The cathode according to claim 1, wherein the second cathode active material layer completely covers a surface of the first cathode active material layer.**

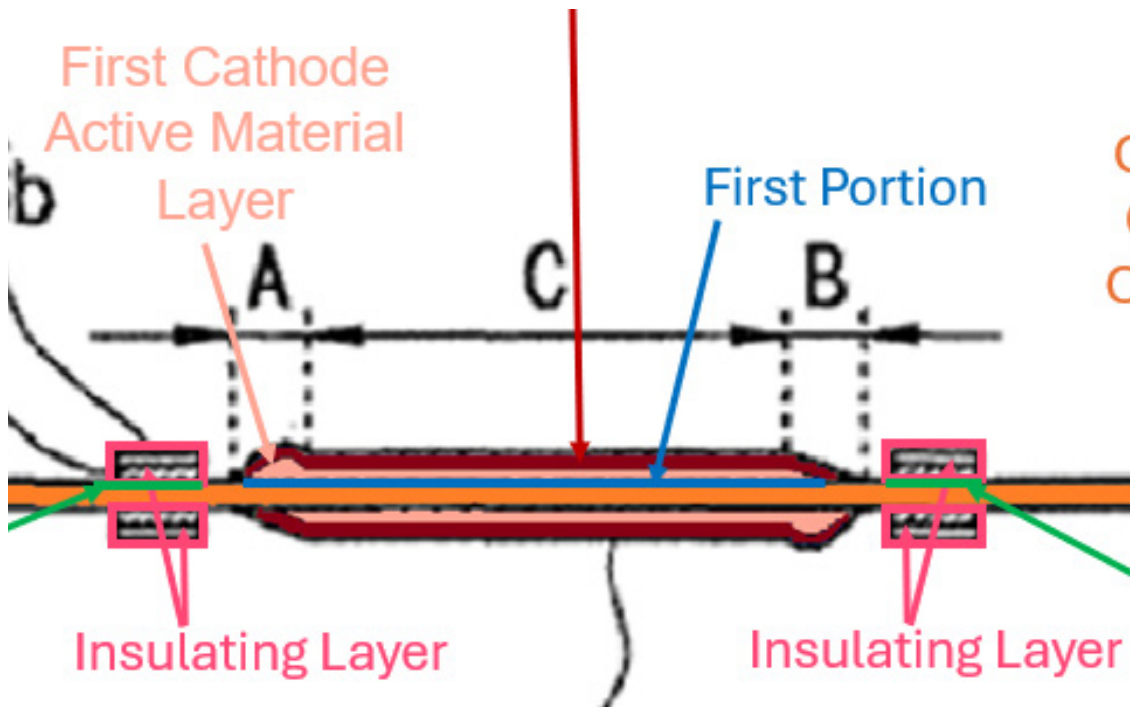
231. The combination of Kim in view of Sikha teaches this claim element. See above §§ XVI.A, XVI.B.4. Specifically, Sikha describes that “a second slurry mixture comprising a cathodically active material is deposited on the first cathode material layer 210 to form a second cathode material layer 220.” EX1008 (Sikha), [0053]. This deposition results in a second cathode material layer 220 that covers first cathode material layer 210, as shown in Figure 2C of Sikha:



EX1008 (Sikha), FIG. 2C (annotated).

232. In the above combination of Kim in view of Sikha, Kim’s positive electrode coating portion 22 would be replaced by forming Sikha’s first cathode material layer 210 on Kim’s positive electrode current collector 21, and then

forming Sikha's second cathode material layer 220 on the first cathode material layer 210, as shown below:



EX1007 (Kim), FIG. 2B (annotated as above, abridged and enlarged).

233. Thus, the above combination of Kim in view of Sikha renders obvious this claim limitation. *See above* §§ XVI.A, XVI.B.4.

**F. Claim 5. The cathode according to claim 1, wherein the thickness of the first cathode active material layer is from about 0.1  $\mu\text{m}$  to about 20  $\mu\text{m}$ .**

234. The combination of Kim in view of Sikha teaches this claim element. *See above* §§ XVI.A, XVI.B.4. Although Kim does not disclose a specific thickness for the active material layer formed on positive electrode coating portion 22, Kim does describe that such thickness must be at least about 24  $\mu\text{m}$  or more. EX1007 (Kim), 6:58-65 (explaining that insulating member 26 may have a

thickness of at least “about 24  $\mu\text{m}$  or more” but “equal to or less than the thickness of the positive electrode coating portion 22”). Sikha, however, explicitly describes that “the first cathode material layer 210 has a thickness between about 10  $\mu\text{m}$  to about 150  $\mu\text{m}$ ,” or “from about 1 to 80 microns.” EX1008 (Sikha), [0038], [0068].

235. In the resulting combination of Kim as modified in view of Sikha, the thickness of Sikha’s first cathode material layer 210 would be at least between 10 and 80  $\mu\text{m}$ , or more broadly between 1 and 150  $\mu\text{m}$ . Either of these ranges overlap with the range of from about 0.1  $\mu\text{m}$  to about 20  $\mu\text{m}$ , as recited by claim 5. Thus, the above combination of Kim in view of Sikha renders obvious this claim limitation. *See above* §§ XVI.A, XVI.B.4.

**G. Claim 6. The cathode according to claim 1, wherein the first cathode active material and the second cathode active material are each independently selected from the group consisting of lithium cobaltate, lithium iron phosphate, lithium manganese iron phosphate, sodium iron phosphate, lithium vanadium phosphate, sodium vanadium phosphate, oxy-lithium-vanadium phosphate, oxy-sodium-vanadium phosphate, lithium vanadate, lithium manganate, lithium nickelate, lithium nickel cobalt manganese oxide, lithium-rich manganese-based material, lithium nickel cobalt aluminum oxide, lithium titanate and combinations thereof.**

236. The combination of Kim in view of Sikha teaches this claim element. *See above* §§ XVI.A, XVI.B.4. In particular, Sikha describes that, in some embodiments, “different cathodically active materials are used for each layer” of the first cathode material layer 210 and the second cathode material layer 220.

EX1008 (Sikha), [0063]. Such “cathodically active materials” may include “lithium cobalt oxide ( $\text{LiCoO}_2$ )” (the claimed “lithium cobaltate”), “ $\text{Li}_3\text{V}_2(\text{PO}_4)_3$ ” (the claimed “lithium vanadium phosphate”), “ $\text{LiMn}_2\text{O}_4$ ” (the claimed “lithium manganate”), “iron olivine ( $\text{LiFePO}_4$ )” (the claimed “lithium iron phosphate”), “ $\text{LiVOPO}_4$ ” and “ $\text{LiVPO}_4\text{F}$ ” (the claimed “oxy-lithium-vanadium phosphate” and a fluorinated oxy-lithium vanadium phosphate), “ $\text{Na}_5\text{V}_2(\text{PO}_4)_2\text{F}_3$ ” (a fluorinated version of the claimed “oxy-sodium-vanadium phosphate”), and “ $\text{LiNi}_x\text{Co}_{1-2x}\text{Mn}_x\text{O}_2$  (‘NMC’)” (the claimed “lithium nickel cobalt manganese oxide”), as well as many other similar compounds, including “lithium manganese dioxide ( $\text{LiMnO}_2$ ), titanium disulfide ( $\text{TiS}_2$ ),” “iron olivine” variants “(such as  $\text{LiFe}_{1-x}\text{Mg}_x\text{PO}_4$ ),”  $\text{LiMoPO}_4$ ,  $\text{LiCoPO}_4$ ,”  $\text{LiMP}_2\text{O}_7$ ,  $\text{LiFe}_{1.5}\text{P}_2\text{O}_7$ ,” “ $\text{LiAlPO}_4\text{F}$ ,  $\text{Li}_5\text{V}(\text{PO}_4)_2\text{F}_2$ ,  $\text{Li}_5\text{Cr}(\text{PO}_4)_2\text{F}_2$ ,  $\text{Li}_2\text{CoPO}_4\text{F}$ ,  $\text{Li}_2\text{NiPO}_4\text{F}$ ,” “ $\text{Li}_2\text{FeSiO}_4$ ,  $\text{Li}_2\text{MnSiO}_4$ ,  $\text{Li}_2\text{VOSiO}_4$ ,” as well as “composites thereof and combinations thereof.” EX1008 (Sikha), [0041].

237. In the resulting combination of Kim as modified in view of Sikha, Kim’s positive electrode coating portion 22 would be replaced with Sikha’s first cathode material layer 210 and second cathode material layer 220. *See above* §§ XVI.A, XVI.B.4. And the first cathode material layer 210 would be formed of one of the above materials listed by Sikha, where Sikha discloses many members that overlap with the Markush group of materials recited by claim 6.

- H. Claim 7. The cathode according to claim 1, wherein the first cathode active material layer and the second cathode active material layer each further comprise a binder and a conductive agent, wherein the binder is selected from the group consisting of polyvinylidene fluoride, a vinylidene fluoride-hexafluoropropylene copolymer, polyamide, polyacrylonitrile, polyacrylate ester, polyacrylic acid, polyacrylate salt, sodium carboxymethyl cellulose, polyvinylpyrrolidone, polyvinyl ether, polymethyl methacrylate, polytetrafluoroethylene, polyhexafluoropropylene, styrene butadiene rubber and combinations thereof; and the conductive agent is selected from the group consisting of carbon nanotubes, conductive carbon black, acetylene black, graphene, Ketjen black, carbon fibers and combinations thereof.**

238. The combination of Kim in view of Sikha teaches this claim element.

*See above* §§ XVI.A, XVI.B.4. In particular, Sikha describes that “[t]he first slurry mixture may further comprise a solid binding agent or precursors for forming a solid binding agent” as well as “electro-conductive materials for providing a conductive path between the highly resistive particles of the cathodically active materials.” EX1008 (Sikha), [0044], [0046].

239. Sikha describes that the binding agent may include “styrene butadiene rubber (SBR)” (as claimed), “carboxymethylcellulose (CMC)” (similar to the claimed “sodium carboxymethyl cellulose”), and “polyvinylidene fluoride (PVDF)” (as claimed), as well as “combinations thereof.” EX1008 (Sikha), [0044].

240. Sikha also describes that the “electro-conductive materials” “may be selected from the group comprising: graphite, graphene hard carbon” (as claimed), “acetylene black (AB)” (as claimed), “carbon black (CB)” (as claimed), and other

similar materials including “carbon coated silicon, tin particles, tin oxide, silicon carbide, silicon (amorphous or crystalline), silicon alloys, doped silicon, lithium titanate, composites thereof, and combinations thereof.” EX1008 (Sikha), [0046].

241. Sikha further describes that “[t]he second slurry mixture may be similar to the first slurry mixture as described herein” and “may comprise “cathodically active materials and at least one of a binder, electro-conductive material and a solvent.” EX1008 (Sikha), [0053].

242. In the resulting combination of Kim as modified in view of Sikha, Kim’s positive electrode coating portion 22 would be replaced with Sikha’s first cathode material layer 210 and second cathode material layer 220. *See above* §§ XVI.A, XVI.B.4. And the first cathode material layer 210 and the second cathode material layer 220 would be formed to include the “binding agent” and “electro-conductive materials” explicitly taught by Sikha, where Sikha discloses many members that overlap with the two Markush groups of materials recited by claim 7.

- I. Claim 8. The cathode according to claim 1, wherein the insulating layer comprises at least one of inorganic particles and a polymer, wherein the inorganic particles are selected from the group consisting of aluminum oxide, silicon dioxide, magnesium oxide, titanium oxide, hafnium oxide, tin oxide, cerium dioxide, nickel oxide, zinc oxide, calcium oxide, zirconium dioxide, yttrium oxide, silicon carbide, boehmite, aluminum hydroxide, magnesium hydroxide, calcium hydroxide, barium sulfate and combinations thereof; and the polymer is selected from the group consisting of a homopolymer of vinylidene fluoride, a copolymer of vinylidene fluoride, a copolymer of hexafluoropropylene, polystyrene, polyphenylacetylene, sodium poly(vinyl acid), potassium**

**poly(vinyl acid), polymethyl methacrylate, polyethylene, polypropylene, polytetrafluoroethylene and combinations thereof.**

243. Kim discloses that insulating member 26 “may include an adhesive layer and an insulating film adhered to one surface thereof,” where “the insulating film may be formed of polypropylene, polyethylene terephthalate, or polyethylene naphthalate.” EX1007 (Kim), 4:40-50. Thus, Kim discloses an insulating layer comprising a polymer that is polypropylene, which is selected from the Markush group recited by claim 8.

**J. Independent Claim 9**

**1. 9.P. An electrochemical device, comprising**

244. Kim discloses “[a]n electrode assembly and a secondary battery.” EX1007 (Kim), Abstract, 1:14-18. Kim further discloses that the electrode assembly of the secondary battery “includes a first electrode plate ... 20, a second electrode plate ... 30 and a separator 40,” where the first (positive) electrode plate comprises an “active material” formed of “at least one of a complex oxide and lithium.” EX1007 (Kim), 3:45-49, 4:19-22. This is the same kind of electrochemical device used in the same context for the same purpose as that of the ’769 patent.

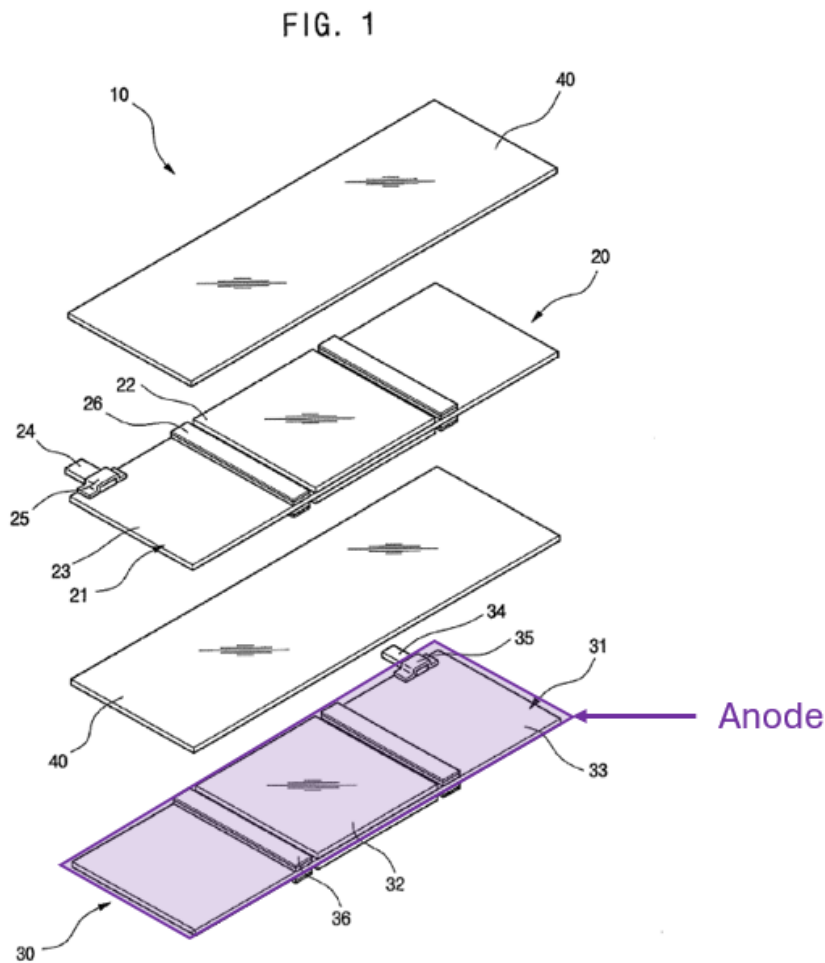
**2. 9.A: an anode,**

245. Kim discloses that electrode assembly 10 includes “a negative electrode plate including a negative electrode collector on which a negative

electrode coating portion and a negative electrode non-coating portion are formed.”

EX1007 (Kim), 3:43-49; *see also* EX1007 (Kim), Abstract, 2:29-45, 2:60-3:7, FIG.

1. Kim’s negative electrode plate including a negative electrode collector and a negative electrode coating portion are the same as the anode recited by limitation 9.A.

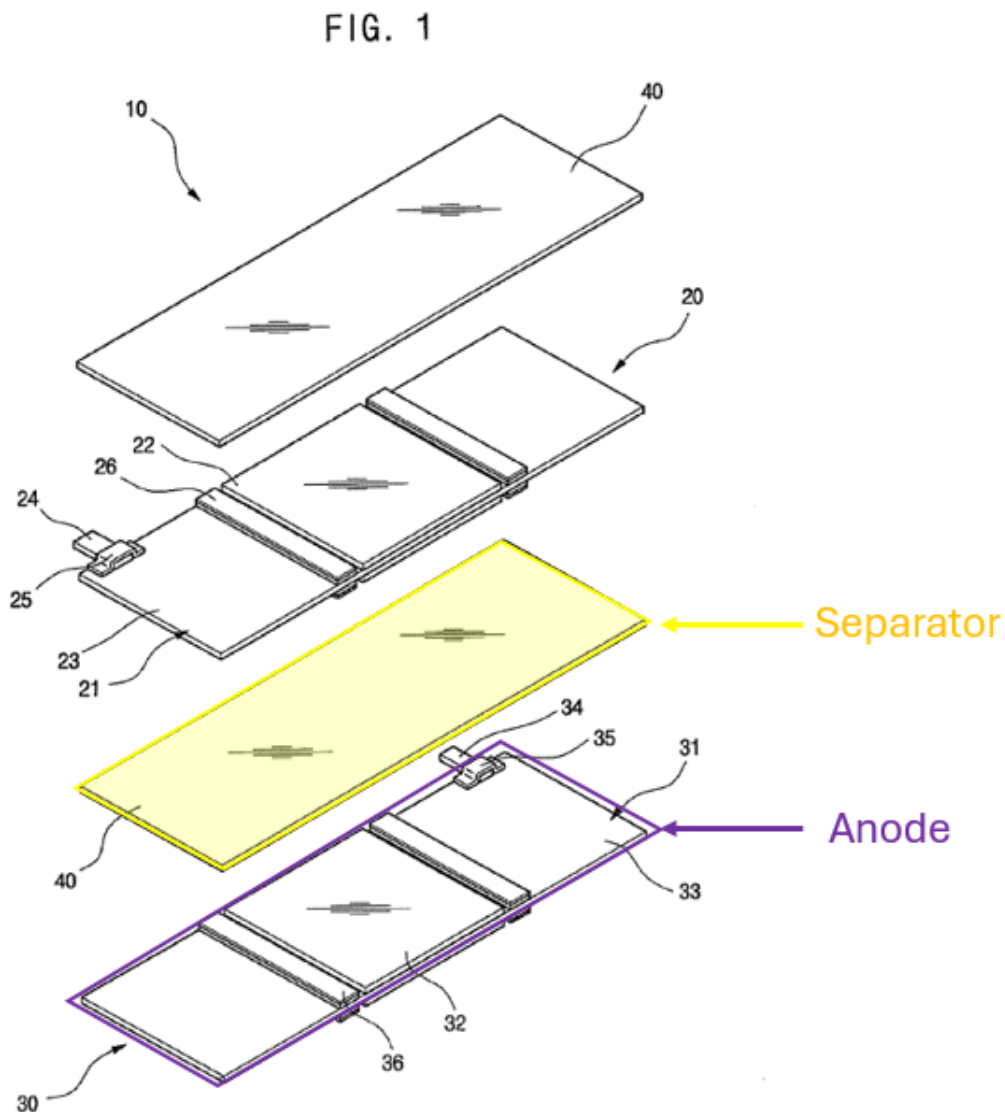


EX1007 (Kim), FIG. 1 (annotated).

**3. 9.B: a separator and**

246. Kim discloses that electrode assembly 10 includes “a separator 40” that is “disposed between the positive electrode plate and the negative electrode

plate.” EX1007 (Kim), 2:29-45, 3:43-49, FIG. 1. Kim’s separator 40 “is generally formed of a thermoplastic resin, such as polyethylene or polypropylene, and the surface of the separator 40 is generally porous” and controls the “migration of lithium ions between the positive electrode plate 20 and the negative electrode plate 30.” EX1007 (Kim), 5:44-56. Kim’s separator is the same as the separator recited by limitation 9.B.



**4. 9.C: a cathode, wherein the cathode comprises**

247. Kim discloses a cathode as discussed above in [1.P]. *See above* § XVI.B.1.

**5. 9.D: a cathode current collector, having a first surface;**

248. Kim discloses a cathode current collector as discussed above in [1.A].  
*See above* § XVI.B.2.

**6. 9.E: a first cathode active material layer, comprising a first cathode active material;**

249. Kim discloses a first cathode active material layer comprising a first cathode active material, as discussed above in [1.B]. *See above* § XVI.B.3.

**7. 9.F: a second cathode active material layer, comprising a second cathode active material; and**

250. The combination of Kim in view of Sikha teaches a second cathode active material layer comprising a second cathode active material, as discussed above in [1.C]. *See above* § XVI.B.4.

**8. 9.G: an insulating layer, wherein**

251. Kim discloses an insulating layer as discussed above in [1.D]. *See above* § XVI.B.5.

- 9. 9.H: the first cathode active material layer is disposed between the cathode current collector and the second cathode active material layer and covers a first portion of the first surface of the cathode current collector, and**

252. The combination of Kim in view of Sikha teaches the first cathode active material layer is disposed between the cathode current collector and the second cathode active material layer and covers a first portion of the first surface of the cathode current collector, as discussed above in [1.E]. *See above* § XVI.B.6.

- 10. 9.I: the insulating layer covers a second portion of the first surface of the cathode current collector that is different from the first portion,**

253. Kim discloses that the insulating layer covers a second portion of the first surface of the cathode current collector that is different from the first portion, as discussed above in [1.F]. *See above* § XVI.B.7.

- 11. 9.J: wherein a thickness of the insulating layer is greater than a thickness of the first cathode active material layer; and**

254. The combination of Kim in view of Sikha teaches that a thickness of the insulating layer is greater than a thickness of the first cathode active material layer, as discussed above in [1.G]. *See above* § XVI.B.8.

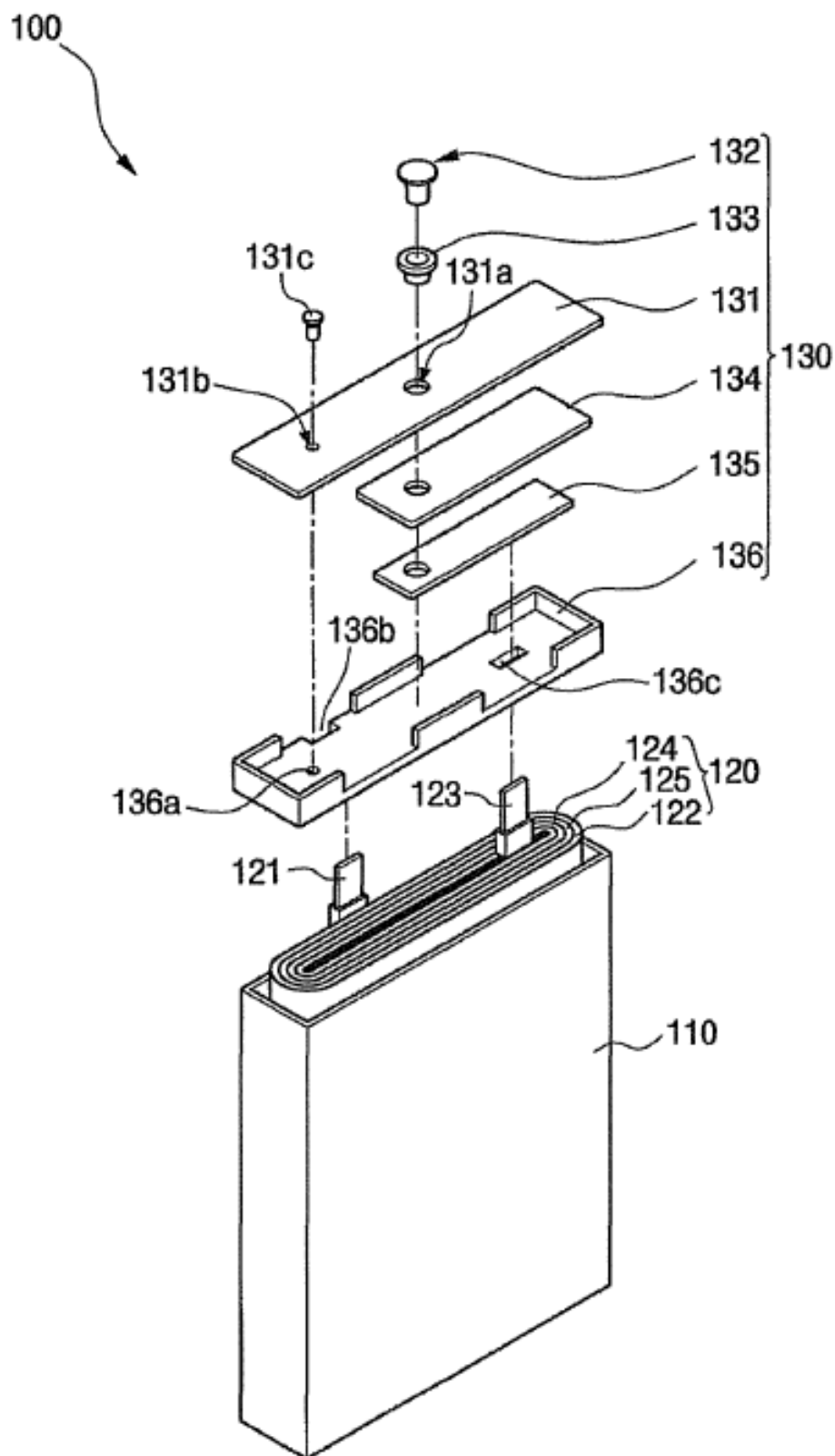
- 12. 9.K: the separator is disposed between the anode and the cathode,**

255. Kim discloses that “a separator 40” is “disposed between the positive electrode plate and the negative electrode plate” and thereby is able to control “migration of lithium ions between the positive electrode plate 20 and the negative

electrode plate 30.” EX1007 (Kim), 2:29-45, 3:43-49, 5:44-56, FIG. 1. Thus, Kim’s separator is disposed in the same position and for the same function as the separator recited in limitation 9.K.

**13. 9.L: and the anode, the separator, and the cathode are wound to form an electrode assembly.**

256. Kim discloses that “positive electrode plate 20, the negative electrode plate 30, and the separator 40,” are “stacked and wound in a jelly-roll type electrode assembly.” EX1007 (Kim), 3:50-57, FIG. 3. Thus, Kim’s electrode assembly 10 is formed by the anode, the separator, and the cathode being wound to form an electrode assembly, as recited by limitation 9.L.



EX1007 (Kim), FIG. 3.

- K. Claim 10. The electrochemical device according to claim 9, wherein a first distance exists between the insulating layer and the first cathode active material layer in a longitudinal direction of the cathode current collector, a second distance exists between the insulating layer and the second cathode active material layer in the longitudinal direction of the cathode current collector; and the first distance and the second distance are respectively greater than or equal to 0 and the second distance is less than or equal to the first distance.**

257. The combination of Kim in view of Sikha teaches this claim limitation, as discussed above for claim [2]. *See above* § XVI.C.

- L. Claim 12. The electrochemical device according to claim 10, wherein the first distance between the insulating layer and the first cathode active material layer in the longitudinal direction of the cathode current collector satisfies the following formula:  $0 \leq \text{the first distance} \leq \pi/4 D+4 \text{ mm}$ .**

258. The combination of Kim in view of Sikha teaches this claim limitation for the same reasons as those discussed above in claim [2]. *See above* § XVI.C. In particular, Kim discloses that an “insulating member 26 may be formed adjacent to at least one of the ends of the electrode coating portion 22,” such that “a distance” is provided “between the insulating member 26 and the positive electrode coating portion 22.” EX1007 (Kim), 6:25-57. Kim discloses that, based on several physical limitations, “the insulating member 26 may be formed to be spaced 3.5 mm or less apart from the end part of the positive electrode coating portion 22.” EX1007 (Kim), 6:49-52.

259. The above combination of Kim and Sikha teaches this claim element.

In particular, in the resulting combination of Kim as modified in view of Sikha, there would be a distance between insulating member 26 and first cathode active material layer 210 (the claimed “first distance”), as explicitly taught by Kim. 6:25-57. This distance would be greater than zero and less than or equal to 3.5 mm, as described by Kim. EX1007 (Kim), 6:49-52. This range overlaps the range of first distance that is, at a minimum, between 0 mm and 4 mm, as recited by claim 12 (in the limit that D is zero). Thus, the above combination of Kim in view of Sikha renders obvious this claim limitation. *See above* §§ XVI.A, XVI.B.4.

**M. Claim 13. The electrochemical device according to claim 10, wherein the second distance between the insulating layer and the second cathode active material layer in the longitudinal direction of the cathode current collector satisfies the following formula:  $0 \leq \text{the second distance} \leq \pi/4 D + 4 \text{ mm}$ .**

260. The combination of Kim in view of Sikha teaches this claim limitation for the same reasons as those discussed above in claims [2] and [12]. *See above* §§ XVI.C and XVI.K. In particular, Kim discloses that an “insulating member 26 may be formed adjacent to at least one of the ends of the electrode coating portion 22,” such that “a distance” is provided “between the insulating member 26 and the positive electrode coating portion 22.” EX1007 (Kim), 6:25-57. Kim discloses that, based on several physical limitations, “the insulating member 26 may be formed to

be spaced 3.5 mm or less apart from the end part of the positive electrode coating portion 22.” EX1007 (Kim), 6:49-52.

261. The above combination of Kim and Sikha teaches this claim element. In particular, in the resulting combination of Kim as modified in view of Sikha, there would be a distance between insulating member 26 and second cathode active material layer 220 (the claimed “second distance”), as explicitly taught by EX1007 (Kim), 6:25-57. This distance would be greater than zero and less than or equal to 3.5 mm, as described by Kim. EX1007 (Kim), 6:50-52. This range overlaps the range of second distance that is, at a minimum, between 0 mm and 4 mm, as recited by claim 13 (in the limit that D is zero). Thus, the above combination of Kim in view of Sikha renders obvious this claim limitation. *See above* §§ XVI.A, XVI.B.4.

## **N. Independent Claim 15**

### **1. 15.P: An electronic device, comprising**

262. Kim discloses as background that the electrode assembly may be used in a variety of electronic devices such as “various compact and handheld electronic/electrical appliances, such as cellular phones, notebook computers, camcorders, and like device.” EX1007 (Kim), 1:21-29. Kim’s electronic device is of the same type as the electronic device recited by the ’769 patent. Thus, Kim discloses the electronic device recited by limitation [15.P].

**2. 15.A: an electrochemical device, wherein the electrochemical device comprises**

263. Kim discloses an electrochemical device as discussed above in [9.P].

*See above* § XVI.J.1.

**3. 15.B: an anode,**

264. Kim discloses an anode as discussed above in [9.A]. *See above* § XVI.J.2.

**4. 15.C: a separator and**

265. Kim discloses a separator as discussed above in [9.B]. *See above* § XVI.J.3.

**5. 15.D: a cathode, wherein the cathode comprises**

266. Kim discloses a cathode as discussed above in [1.P] and [9.C]. *See above* §§ XVI.B.1 and XVI.J.4.

**6. 15.E: a cathode current collector, having a first surface;**

267. Kim discloses a cathode current collector as discussed above in [1.A] and [9.D]. *See above* §§ XVI.B.2 and XVI.J.5.

**7. 15.F: a first cathode active material layer, comprising a first cathode active material;**

268. Kim discloses a first cathode active material layer comprising a first cathode active material, as discussed above in [1.B] and [9.E]. *See above* §§ XVI.B.3 and XVI.J.6.

**8. 15.G: a second cathode active material layer, comprising a second cathode active material; and**

269. The combination of Kim in view of Sikha teaches a second cathode active material layer comprising a second cathode active material, as discussed above in [1.C] and [9.F]. *See above* §§ XVI.B.4 and XVI.J.7.

**9. 15.H: an insulating layer, wherein**

270. Kim discloses an insulating layer as discussed above in [1.D] and [9.G]. *See above* §§ XVI.B.5 and XVI.J.8.

**10. 15.I: the first cathode active material layer is disposed between the cathode current collector and the second cathode active material layer and covers a first portion of the first surface of the cathode current collector, and**

271. The combination of Kim in view of Sikha teaches these claim features, as discussed above in [1.E] and [9.H]. *See above* §§ XVI.B.6 and XVI.J.9.

**11. 15.J: the insulating layer covers a second portion of the first surface of the cathode current collector that is different from the first portion,**

272. Kim discloses that the insulating layer covers a second portion of the first surface of the cathode current collector that is different from the first portion, as discussed above in [1.F] and [9.I]. *See above* §§ XVI.B.7 and XVI.J.10.

- 12. 15.K: wherein a thickness of the insulating layer is greater than a thickness of the first cathode active material layer; and**

273. The combination of Kim in view of Sikha teaches that the thickness of the insulating layer is greater than a thickness of the first cathode active material layer, as discussed above in [1.G] and [9.J]. *See above* §§ XVI.B.8 and XVI.J.11.

- 13. 15.L: the separator is disposed between the anode and the cathode, and**

274. Kim discloses that the separator is disposed between the anode and the cathode, as discussed above in [9.K]. *See above* § XVI.J.12.

- 14. 15.M: the anode, the separator, and the cathode are wound to form an electrode assembly.**

275. Kim discloses that the anode, the separator, and the cathode are wound to form an electrode assembly, as discussed above in [9.L]. *See above* § XVI.J.13.

- O. Claim 16. The electronic device according to claim 15, wherein a first distance exists between the insulating layer and the first cathode active material layer in a longitudinal direction of the cathode current collector, a second distance exists between the insulating layer and the second cathode active material layer in the longitudinal direction of the cathode current collector; and the first distance and the second distance are respectively greater than or equal to 0 and the second distance is less than or equal to the first distance.**

276. Kim discloses these claim features for the same reasons as those discussed above regarding claim [2]. *See above* § XVI.C.

- P. Claim 18. The electronic device according to claim 16, wherein the first distance between the insulating layer and the first cathode active material layer in the longitudinal direction of the cathode current collector satisfies the following formula:  $0 \leq \text{the first distance} \leq \pi/4 D+4 \text{ mm}$ ; and the second distance between the insulating layer and the second cathode active material layer in the longitudinal direction of the cathode current collector satisfies the following formula:  $0 \leq \text{the second distance} \leq \pi/4 D+4 \text{ mm}$ .**

277. Kim discloses these claim features for the same reasons as those discussed above regarding claims [2], [12], and [13]. *See above* §§ XVI.C, XVI.L, and XVI.M.

**XVII. GROUND 2B: CLAIM 8 IS OBVIOUS IN VIEW OF KIM, SIKHA, AND YAMAFUKU**

278. A POSA would have been motivated to modify the electrode assembly of Kim as modified in view of Sikha further in view of Yamafuku. This is because doing so would have yielded predictable and well-known advantages in manufacturability, energy density, and mechanical robustness.

279. To start, Yamafuku is analogous to each of Kim, Sikha, and the '769 patent. The '769 patent is broadly directed towards “the field of electrochemical devices, and more particularly, to a cathode and a lithium-ion battery” that “adopts an active material layer in a two-layer structure” and “adjust[s] the gap between the active material layer and the insulating” to avoid “a failure caused by an internal short circuit” in the electrochemical device. EX1001 ('769 patent), 1:17-19, 1:45-57. Kim discloses “an electrode assembly and a secondary battery” that includes

“an insulating member disposed on one side of the positive or negative electrode non-coating portion” to achieve “improve[d] efficiency and stability.” EX1007 (Kim), 1:14-19, 2:26-41. Likewise, Sikha describes “high-capacity energy storage devices” (e.g., “lithium-ion batteries”) that include “a multi-layer cathode structure” to create “faster charging, higher capacity energy storage devices that are smaller, lighter, and can be more cost effectively manufactured at a high production rate.” EX1008 (Sikha), [0002], [0009], [0010]. And Yamafuku describes the structure of a cathode used in a wound-type electrode assembly of a lithium-ion battery. EX1006 (Yamafuku), [0002], [0004], [0043], [0059].

280. As explained above, the combination of Kim in view of Sikha teaches a “jelly-roll type” wound electrode assembly that is formed of first and second cathode material layers disposed on a positive electrode collector 21, a separator 40, and a negative electrode plate. EX1007, 3:50-57, 4:51-62, 5:44-56, FIGS. 2A-2C, 3; EX1008, [0038], [0053], FIG. 2C; *see above* §XVI.A. A POSA would have recognized that it would have been obvious to modify Kim’s wound-type electrode with Sikha’s multi-layer cathode structure to achieve the predictable result of an electrode assembly, yielding a lithium ion battery that is faster charging, higher capacity, higher power, and has a longer cycle time; that is smaller, lighter, and more cost effective than single-layer lithium-ion batteries storing the same amount of energy. EX1008, [0009], [0024]. Thus, a POSA would have found it obvious to

modify Kim in view of Sikha to arrive at a wound-type electrode assembly with a multi-layer cathode structure.

281. Yamafuku, teaches a wound-type electrode assembly that is formed of “a sheet-like positive electrode 3 and a sheet-like negative electrode 5 overlapped with positive electrode 3” with “a separator 4 arranged between” the two electrodes. EX1006 (Yamafuku), [0058]-[0059]. Thus, like Kim, Yamafuku employs a wound-type electrode assembly comprising “a sheet-like positive electrode 3 and a sheet-like negative electrode 5 [that] are overlapped via a separator.” EX1006 (Yamafuku), [0202], FIG. 7. Thus, a POSA would have understood that the electrode assemblies of Yamafuku and Kim-Sikha are similar and compatible.

282. Yamafuku describes that, in such wound electrode assemblies, “the electrodes are opposite to each other so that the respective active materials layers are adjacent to each other via a separator.” EX1006 (Yamafuku), [0006]. However, Yamafuku recognizes that “the separator of the electrode assembly may shrink,” which may lead to a short circuit.” EX1006 (Yamafuku), [0007]. To avoid such a short circuit due to shrinkage of the separator, Yamafuku teaches enhancing “the insulation properties” of “an insulating layer on one electrode” of the electrode assembly. EX1006 (Yamafuku), [0008]-[0009]. Yamafuku achieves such enhanced

“insulation properties” by incorporating inorganic particles into the insulating layer. *See, e.g.*, EX1006 (Yamafuku), [0049].

283. In particular, Yamafuku’s insulating layer “contains an insulating material and a third binder.” EX1006 (Yamafuku), Abstract. The insulating material “include[s] inorganic particles and a resin,” where the inorganic particles may constitute “particles made from iron oxide,  $\text{SiO}_2$ ,  $\text{Al}_2\text{O}_3$ ,  $\text{TiO}_2$ ,  $\text{BaTiO}_2$ ,  $\text{ZrO}$ , an alumina-silica composite oxide, and the like.” EX1006 (Yamafuku), [0127]-[0129]. Yamafuku’s third binder may be an aqueous binder formed of, for example, “polyethylene oxide (polyethylene glycol), polypropylene oxide (polypropylene glycol), polyvinyl alcohol, polyacrylic acid, polymethacrylic acid, polytetrafluoroethylene (PTFE), a styrene butadiene rubber (SBR), polyolefin, a nitrile-butadiene rubber and cellulose, and more.” EX1006 (Yamafuku), [0067]. Thus, Yamafuku teaches using an insulating layer comprising *both* inorganic particles (e.g., “inorganic particles” of silicon oxide) *and* a polymer (e.g., polyethylene, polypropylene, etc.).

284. A POSA would not have experienced any unreasonable technical challenges in modifying the combination of Kim in view of Sikha further in view of Yamafuku. Kim, Sikha, and Yamafuku each coat similar cathode active materials onto a cathode current collector by mixing the active material into a solvent, which is subsequently evaporated from the cathode current collector.

EX1007 (Kim), 4:15-22, 6:7-24; EX1008 (Sikha), [0038]-[0041], [0051]; EX1006 (Yamafuku), [0098]-[0099], [0184]. Thus, the production methods employed by Yamafuku could readily be implemented to form the wound-type electrode of Kim-Sikha.

285. And a POSA would have recognized that the problem of a short circuit caused by shrinkage of the insulating layer, as described by Yamafuku, may also be of concern in the multi-layer cathode structure of Kim as modified in view of Sikha. This is because Kim also uses an insulating layer disposed on one of the electrodes, just as in Yamafuku. *Compare* EX1007 (Kim), 6:37-50 *with* EX1006 (Yamafuku), [0043]. Thus, a POSA would understand that modifying the cathode structure of Kim-Sikha further in view of Yamafuku's insulating layer would avoid the same kind of short circuit as that described by Yamafuku. EX1006 (Yamafuku), [0008]-[0009].

286. Modifying Kim-Sikha further in view of Yamafuku would have yielded the predictable result of a lithium-ion secondary battery having a wound-type electrode assembly that is more resilient to short circuits caused by shrinkage of the insulating layer. EX1006 (Yamafuku), [0008]-[0009]. Thus, a POSA would have found it obvious to modify the combination of Kim in view of Sikha further in view of Yamafuku to arrive at a wound-type electrode assembly having an

insulating layer with excellent insulation properties. EX1006 (Yamafuku), [0009], [0210].

- A. Claim 8. The cathode according to claim 1, wherein the insulating layer comprises at least one of inorganic particles and a polymer, wherein the inorganic particles are selected from the group consisting of aluminum oxide, silicon dioxide, magnesium oxide, titanium oxide, hafnium oxide, tin oxide, cerium dioxide, nickel oxide, zinc oxide, calcium oxide, zirconium dioxide, yttrium oxide, silicon carbide, boehmite, aluminum hydroxide, magnesium hydroxide, calcium hydroxide, barium sulfate and combinations thereof; and the polymer is selected from the group consisting of a homopolymer of vinylidene fluoride, a copolymer of vinylidene fluoride, a copolymer of hexafluoropropylene, polystyrene, polyphenylacetylene, sodium poly(vinyl acid), potassium poly(vinyl acid), polymethyl methacrylate, polyethylene, polypropylene, polytetrafluoroethylene and combinations thereof.**

287. The combination of Kim-Sikha further in view of Yamafuku teaches these claim elements. In particular, Kim discloses that insulating member 26 may include an insulating film “formed of polypropylene, polyethylene, terephthalate, or polyethylene naphthalate.” EX1007 (Kim), 4:45-50. Thus, Kim discloses an insulating layer comprising a polymer that is “polypropylene” or “polyethylene” (as claimed).

288. The combination of Kim-Sikha further in view of Yamafuku teaches an insulating layer comprising inorganic particles. In particular, Yamafuku describes forming an insulating layer that comprises a binder or resin of, for example, a “polyolefin” (e.g., the polypropylene and polyethylene disclosed by Kim) and inorganic particles “including, preferably, “SiO<sub>2</sub> particles, Al<sub>2</sub>O<sub>3</sub>

particles, boehmite (hydrated alumina), and alumina-silica composite oxide particles.” EX1006 (Yamafuku), [0127]-[0136], *esp.* [0136]. Thus, the combination of Kim-Sikha further in view of Yamafuku teaches all the elements recited by claim 8.

**XVIII.     GROUND 2C: CLAIMS 11 AND 17 ARE OBVIOUS IN VIEW OF KIM, SIKHA, AND LI**

289. A POSA would have been motivated to modify the electrode assembly of Kim-Sikha further in view of Li. This is because Li identifies a particular problem with the wound electrode structure of Kim-Sikha and describes a specific solution to that problem.

290. To start, Li is analogous to each of Kim, Sikha, and the ’769 patent. The ’769 patent is broadly directed towards “the field of electrochemical devices, and more particularly, to a cathode and a lithium-ion battery” that “adopts an active material layer in a two-layer structure” and “adjust[s] the gap between the active material layer and the insulating” to avoid “a failure caused by an internal short circuit” in the electrochemical device. EX1001 (’769 patent), 1:17-19, 1:45-57. Kim discloses “an electrode assembly and a secondary battery” that includes “an insulating member disposed on one side of the positive or negative electrode non-coating portion” to achieve “improve[d] efficiency and stability.” EX1007 (Kim), 1:14-19, 2:37-39. Likewise, Sikha describes “high-capacity energy storage devices” (e.g., “lithium-ion batteries”) that include “a multi-layer cathode

structure” to create “faster charging, higher capacity energy storage devices that are smaller, lighter, and can be more cost effectively manufactured at a high production rate.” EX1008 (Sikha), [0002], [0009], [0010]. And Li is directed towards “a prismatic lithium-ion battery having a winding structure” formed by winding “a positive electrode, a negative electrode, and a separator spaced between the positive electrode and the negative electrode. EX1009 (Li), [0051], [0008].

291. Kim-Sikha teaches “electrode assembly 10 [that] includes the positive electrode plate 20, the negative electrode plate 30, and the separator 40, which are stacked and wound in a jelly-roll type electrode assembly,” wherein the positive electrode plate 20 includes a second cathode material layer 220 disposed on top of a first cathode material layer 210. EX1007 (Kim), 3:50-53; EX1008 (Sikha), [0034], [0038], [0053]. A POSA would have recognized that such an electrode assembly having a multi-layer cathode structure would have resulted in a thicker and denser electrode with improved performance compared to a single-layer cathode structure. EX1008 (Sikha), [0008], [0009], [0024]; *see above* § XVI.A. Thus, a POSA would have found it obvious to modify Kim in view of Sikha to arrive at a wound-type electrode assembly.

292. Li, which published before each of Kim and Sikha, recognizes specific problems with wound-type “prismatic” lithium-ion battery electrode assemblies. Specifically, Li describes that “compared with a battery having a

stacked structure, the battery having a winding structure tends to deform during cycling,” such deformation being caused by “non-uniform stress distribution at different positions inside the battery, so that the battery tends to deform.” EX1009 (Li), [0003]. To avoid this deformation, Li teaches that “a ratio of the thickness of the positive electrode material layer in the corner region of the positive electrode to the thickness of the positive electrode material layer in the body region of the positive electrode is smaller than or equal to 90%.” EX1009 (Li), [0008]. Li also teaches that, while further reduction of deformation is possible by forming the corner region of the positive electrode as “a blank positive electrode current collector,” this also “tends to produce dendritic metal fragments” that may “puncture the separator and cause short circuit of the battery.” EX1009 (Li), [0016]-[0017]. For this reason, Li describes forming an insulating “protective layer” on the uncoated region of the positive electrode current collector. EX1009 (Li), [0017], FIG. 3.

293. Li’s “protective layer” that is formed on uncoated corner regions of the positive electrode current collector is analogous to Kim’s insulating member 26. For example, like Li’s protective layer, Kim’s insulating member 26 is formed on “positive electrode non-coating portion 23.” EX1009 (Li), [0017], FIG. 3; EX1007 (Kim), 4:37-40. In addition, like Li’s protective layer 14, Kim’s insulating member 26 may comprise an “insulating tape” adhered directly to the current

collector. EX1009 (Li), [0021]; EX1007 (Kim), 4:40-50. Thus, a POSA would have understood that the teachings of Li's protective layer 14 would be directly applicable to Kim's insulating member 26.

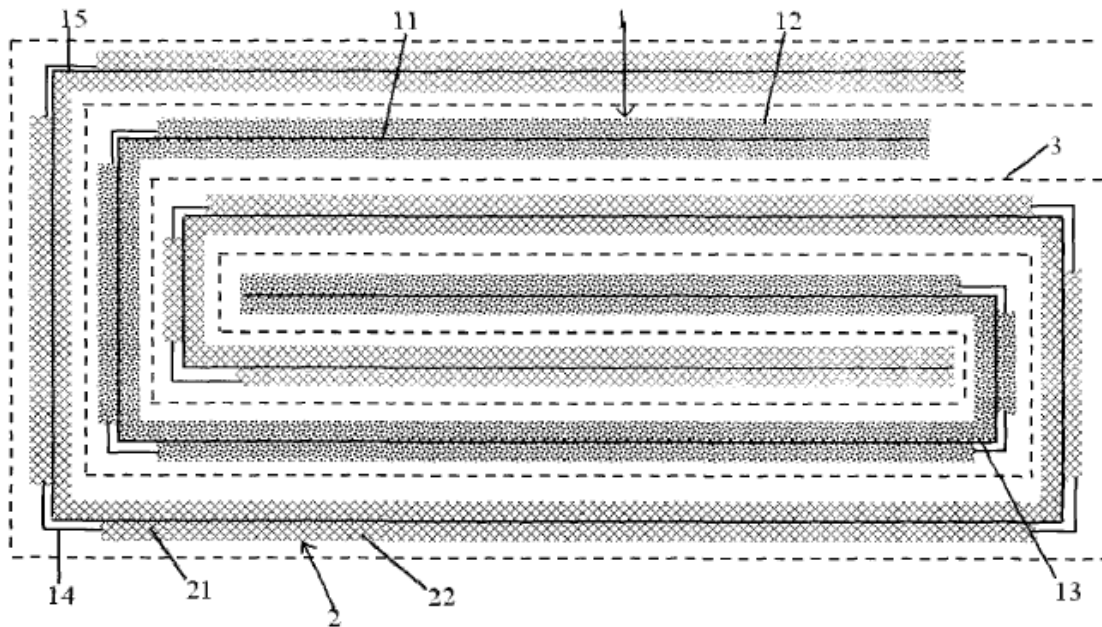
294. In the resulting combination of Kim in view of Sikha and further in view of Li, Kim's insulating member 26 would be disposed on non-coating portions 23 of the positive electrode plate 20 that form the "corner" regions of Kim's wound electrode assembly. This could be accomplished simply by adjusting the widths of Kim's coating portions and winding the electrode assembly to form corners at Kim's non-coating regions.

295. A POSA would have realized that the modification of Kim-Sikha further in view of Li would have predictably resulted in a wound-type electrode assembly that avoids both of the deformation and dendritic particle problems identified by Li years earlier than the publication of either Kim or Sikha. EX1009 (Li), [0005], [0017].

**A. Claim 11: The electrochemical device according to claim 10, wherein the first distance and the second distance are disposed at a corner of the electrode assembly.**

296. To the extent Kim and Sikha do not explicitly describe forming the insulating layer (including the first distance and the second distance) at a corner of the electrode assembly, Li does.

297. In particular, Li describes “a lithium-ion battery having a winding structure, comprising a positive electrode, a negative electrode, a separator, and an electrolyte solution” that are wound into a prismatic cell. EX1009 (Li), Abstract, [0008]. An insulating protective layer 14 is formed in “the corner region[s] 13 of the positive electrode.” EX1009 (Li), [0017]-[0019], [0031], [0035], FIG. 3.



EX1009 (Li), FIG. 3.

298. Li teaches that the positioning of such an insulating protective layer avoids deformation caused by “non-uniform stress distribution” throughout the battery while also avoiding the formation of “dendritic metal fragments” in the cathode collector. EX1009 (Li), [0008]-[0009], [0016]-[0017]. Thus, a POSA would have been motivated to adjust the positioning of Kim’s insulating member in the winding-type electrode assembly of Kim-Sikha to be formed in the corners

of the electrode assembly, as explicitly taught by Li, to avoid deformation of the electrode assembly and formation of dendritic particles.

**B. Claim 17: The electronic device according to claim 16, wherein the first distance and the second distance are disposed at a corner of the electrode assembly.**

299. Kim-Sikha further in view of Li teaches this claim limitation for the same reasons as those discussed above regarding claim 11. *See above* § XVIII.A.

**XIX. GROUND 2D: CLAIMS 14 AND 19 ARE OBVIOUS IN VIEW OF KIM, SIKHA, AND KAPLAN**

300. A POSA would have been motivated to modify the electrode assembly of Kim-Sikha further in view of Kaplan. This is because Kaplan describes a wound electrode assembly formatted as a prismatic cell that is useful in a large number of electronic devices, including digital cameras and cell phones.

301. To start, Kaplan is analogous to each of Kim, Sikha, and the '769 patent. The '769 patent is broadly directed towards “the field of electrochemical devices, and more particularly, to a cathode and a lithium-ion battery” that “adopts an active material layer in a two-layer structure” and “adjust[s] the gap between the active material layer and the insulating” to avoid “a failure caused by an internal short circuit” in the electrochemical device. EX1001 ('769 patent), 1:17-19, 1:45-57. Kim discloses “an electrode assembly and a secondary battery” that includes “an insulating member disposed on one side of the positive or negative electrode non-coating portion” to achieve “improve[d] efficiency and stability.” EX1007

(Kim), 1:14-19, 2:37-39. Likewise, Sikha describes “high-capacity energy storage devices” (e.g., “lithium-ion batteries”) that include “a multi-layer cathode structure” to create “faster charging, higher capacity energy storage devices that are smaller, lighter, and can be more cost effectively manufactured at a high production rate.” EX1008 (Sikha), [0002], [0009], [0010]. And Kaplan is directed towards “secondary lithium batteries, and in particular to lithium prismatic cells” that comprise “a prismatic-shaped housing that houses an anode, a cathode ... and a separator between the anode and the cathode” that are “wound” “to increase the surface area.” EX1010 (Kaplan), [0001], [0007], [0038].

302. Kim-Sikha teaches a “jelly-roll type” wound electrode assembly that is formed of first and second cathode material layers disposed on a positive electrode collector 21, a separator 40, and a negative electrode plate. EX1007 (Kim), 3:50-57, 4:51-62, 5:44-56, FIGS. 2A-2C, 3; EX1008 (Sikha), [0038], [0053], FIG. 2C. A POSA would have recognized that it would have been obvious to modify Kim’s wound-type electrode with Sikha’s multi-layer cathode structure to achieve the predictable result of an electrode assembly that is faster charging, higher capacity, higher power, and has a longer cycle time that is smaller, lighter, and more cost effective than single-layer lithium-ion batteries. EX1008 (Sikha), [0009], [0024]. Thus, a POSA would have found it obvious to modify Kim in view

of Sikha to arrive at a wound-type electrode assembly with a multi-layer cathode structure. *See above* § XVI.A.

303. Kaplan, which published before each of Kim and Sikha, describes a wound-type electrode assembly formed into a “prismatic cell” to make a battery that has “desirable properties for use in digital cameras and other applications.” EX1010 (Kaplan), [0007], [0038], FIG. 5. To begin, Kaplan describes, within the context of the prior art, that “[d]igital cameras and other electronic devices (for example, cell phones, MP3 players, and personal digital assistants (PDA’s) such as BlackBerries®) operate on batteries, such as ... secondary lithium ion batteries.” EX1010 (Kaplan), [0005]. Kaplan also describes that a “secondary, prismatic lithium ion” battery has been used “in digital cameras.” EX1010 (Kaplan), [0005]. Kaplan describes that such a “prismatic cell” “generally [has] a thickness that is much less than their width and length.” EX1010 (Kaplan), [0005].

304. Kaplan then goes on to describe an invention that “features prismatic cell type Li-ion secondary batteries” that “have desirable properties for use in digital cameras and other applications.” EX1010 (Kaplan), [0007]. Kaplan specifically defines such a “prismatic cell” as having “at least four generally flat sides, and [having] one dimension (e.g., thickness) that is substantially smaller than two other dimensions (e.g., length and width).” EX1010 (Kaplan), [0015]. Kaplan describes that such a prismatic cell that is “desirable” “for use in digital cameras”

and other electronic devices “can have a thickness of between about 2 mm and about 15 mm (e.g., between about 4 mm and about 10 mm).” EX1010 (Kaplan), [0015].

305. Kaplan’s “prismatic cell” is analogous to the wound-type electrode assembly of Kim-Sikha. For example, like Kaplan’s prismatic cell, the electrode assembly of Kim-Sikha is a wound-type electrode. EX1010 (Kaplan), [0038], FIG. 5; EX1007 (Kim), 3:50-57. Like Kaplan, the electrode assembly of Kim-Sikha is envisioned as being used to power, for example, “handheld electronic/electrical appliances, such as cellular phones, notebook computers, camcorders, and the like devices.” EX1007 (Kim), 1:21-24. And the electrode assembly of Kim-Sikha includes a cathode formed of an active lithium material, an anode formed of a carbon material, and a porous polymer separator. *Compare* EX1010 (Kaplan), [0007], [0039], [0040] *with* EX1007 (Kim), 3:58-4:2, 5:13-18, 5:44-46; EX1008 (Sikha), [0030]. Thus, a POSA would have understood that the electrode assembly of Kim-Sikha could be configured into the “prismatic cell” form factor described in Kaplan.

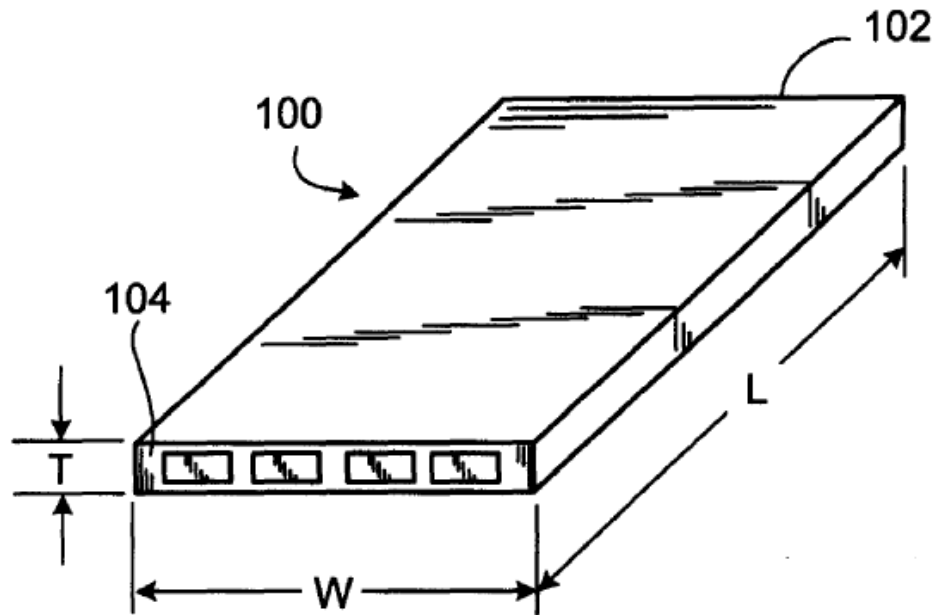
306. In the resulting combination of Kim-Sikha modified in further view of Kaplan, the wound electrode assembly of Kim-Sikha would be configured to have “at least four generally flat sides” such that the thickness “is substantially smaller than two other dimensions (e.g., length and width).” EX1010 (Kaplan), [0015]. In

particular, the electrode assembly of Kim-Sikha would be configured to “have a thickness of between about 2 mm and about 15 mm (e.g., between about 4 mm and about 10 mm),” as explicitly taught by Kaplan. EX1010 (Kaplan), [0015]. A POSA would have realized that forming the electrode assembly of Kim-Sikha into such a prismatic cell would enable the electrode assembly to be used in, for example, “digital cameras” as well as other electronic devices, including “cell phones, MP3 players, and personal digital assistants (PDA’s).” EX1010 (Kaplan), [0005], [0007]. Thus, a POSA would have been motivated to apply the electrode assembly of Kim-Sikha into a prismatic cell, as described by Kaplan, for the predictable result of an electrode assembly that can be used in a large number of electronic devices, including digital cameras and cell phones. And to the extent that Kaplan, which published in 2009, may not have foreseen the impending ubiquity of cell phones, a POSA by the time of Kim and Sikha, which published in 2014 and 2016, respectively, certainly would have.

**A. Claim 14: The electrochemical device according to claim 9, wherein a thickness D of the electrode assembly is from about 1.5 mm to about 50 mm.**

307. To the extent Kim and Sikha do not explicitly describe an electrode assembly having a thickness D that is from about 1.5 mm to about 50 mm, Kaplan does.

308. Kaplan describes “a prismatic lithium ion” battery that may be used, for example, in “[d]igital cameras and other electronic devices (for example, cell phones, MP3 players, and personal digital assistants (PDA’s) such as BlackBerries®.” EX1010 (Kaplan), [0005]. Kaplan describes that, in this context, such a “prismatic lithium ion” battery should have “at least four generally flat sides, and [have] one dimension (e.g., thickness) that is substantially smaller than two other dimensions (e.g., length and width).” EX1010 (Kaplan), [0015]. In particular, Kaplan describes that “a prismatic cell can have a thickness of between about 2 mm and about 15 mm (e.g., between about 4 mm and about 10 mm).” EX1010 (Kaplan), [0015]. Kaplan’s prismatic cell battery “uses a wound electrode design” that is disposed in a housing having “a length L that is greater than its width W, and a thickness T that is substantially smaller than its length and width.” EX1010 (Kaplan), [0029], [0038], FIG. 1.



EX1010 (Kaplan), FIG. 1B.

309. Kaplan's "prismatic" wound-type electrode assembly is analogous to the wound-type electrode assembly of Kim in view of Sikha. *See above* § XIX. Thus, a POSA would have been motivated to modify the wound-type electrode assembly of Kim-Sikha further in view of Kaplan to provide an electrode assembly with a form factor that could be used in a portable electronic device, such as a digital camera, cell phone, MP3 player, or PDA, as explicitly taught by Kaplan.

**B. Claim 19: The electronic device according to claim 15, wherein a thickness D of the electrode assembly is from about 1.5 mm to about 50 mm.**

310. The combination of Kim-Sikha as modified further in view of Kaplan teaches this claim limitation for the same reasons as those discussed above regarding claim 14. *See above* § XIX.A.

**XX. CONCLUSION**

311. 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.

Executed on this 16th day of July in Akron, Ohio.

  
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Yu Zhu, Ph.D.