

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

ZHUHAI COSMX BATTERY CO., LTD.
Petitioner

v.

NINGDE AMPEREX TECHNOLOGY LIMITED,
Patent Owner

Case IPR2026-00399
U.S. Patent No. 12,374,686 B2

**PETITION FOR *INTER PARTES* REVIEW
OF U.S. PATENT NO. 12,374,686**

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37 C.F.R. § 42.104	1-2, 68

PETITIONER'S EXHIBIT LIST

Exhibit No.	Description
1001	U.S. Patent No. 12,374,686 B2 to Liu (“the ’686 patent”)
1002	File History of U.S. Patent No. 12,374,686
1003	Declaration of Yu Zhu, Ph.D.
1004	<i>Curriculum Vitae</i> of Yu Zhu, Ph.D.
1005	Chinese Publication No. 108899475 with Certified English Language Translation (“Hu”)
1006	Japanese Publication No. 2016-122628 with Certified English Language Translation (“Takano”)
1007	U.S. Patent Application Publication No. 2015/0207111 (“Tao”)
1008	U.S. Patent Application Publication No. 2018/0040881 (“Kusagawa”)
1009	Zhibo, M., et al., “Effect of Tab Position on Cylindrical Li-ion Battery Performance,” <i>Battery Bimonthly</i> , Vol. 45, pp. 258-260 (October 2015) with Certified English Language Translation
1010	Chinese Publication No. 103797607 with Certified English Language Translation (“Kakinuma”)
1011	Chinese Publication No. 204809314 with Certified English Language Translation (“Guo”)
1012	U.S. Patent Application Publication No. 2018/0034109 (“Wang”)
1013	Yao, X-Y., et al., “Tab Design and Failures in Cylindrical Li-ion Batteries,” <i>IEEE Access</i> , Vol. 7, pp. 24082-24095 (15 February 2019)
1014	Zhao, W., et al., “Effect of tab design on large-format Li-ion cell performance,” <i>Journal of Power Sources</i> , Vol. 257, pp. 70-79 (2014)

Exhibit No.	Description
1015	Obrovac, M.N. & Chevrier, V.L. “Alloy Negative Electrodes for Li-Ion Batteries,” <i>Chem. Rev.</i> 2014, 114, 11444-11502
1016	Zhang, Y., Zhu, Y., Fu, L., Meng, J., Yu, N., Wang, J. & Wu, Y. “Si/C Composites as Negative Electrodes for High Energy Lithium Ion Batteries,” <i>Chin. J. Chem.</i> , 2017, 35, 21-29.
1017	“Silane Coupling Agents: Combination of Organic and Inorganic Materials,” <i>Resins & Oligomers, Silanes Product Selection Guide</i> , Shin-Etsu Chemical Co., Ltd. (Oct. 2023)
1018	Ma, F., Fu, Y., Battaglia, V. & Prasher, R. “Microrheological modeling of lithium ion battery anode slurry,” <i>Journal of Power Sources</i> , 438 (2019) 226994, 1-8.
1019	U.S. Patent Application Publication No. 2017/0214041 A1 to Minami et al.
1020	Kumudinie, C. “Polymer–Ceramic Nanocomposites: Interfacial Bonding Agents,” <i>Encyclopedia of Materials: Science and Technology</i> , Buschow, K.; et al., eds., Elsevier (2001), 7574-7577, 9780080431529
1021	Chinese Publication No. 101714624 A with Certified English Language Translation (“Li”)
1022	U.S. Patent Application Publication No. 2018/0366775 (“Tao2”) (Continuation Application of Tao, containing identical, clearer figures)

I. INTRODUCTION

Petitioner Zhuhai CosMX Battery Co., Ltd. (“Petitioner” or “CosMX”) requests *inter partes* review (“IPR”) of claims 1-5, 7, and 9-14 of U.S. Patent No. 10,916,686 (“the ’686 patent”) to Ningde Amperex Technology Ltd (“Patent Owner”). These claims are unpatentable under 35 U.S.C. § 103(a).

The ’686 patent claims recite an electrochemical apparatus (such as a lithium-ion battery) with a negative electrode arrangement and active material composition. EX1001, Abstract, 1:25-30. The patent discloses a common technique—using a negative lead, or “tab,” in a recess in the middle of an active material, and controlling the silicon content of the active material, to achieve its stated goals of improved battery performance. *Id.* at Abstract; 1:45-2:19.

II. GROUNDS FOR STANDING (37 C.F.R. § 42.104(A))

The ’686 patent is available for IPR. Petitioner is not barred or estopped from requesting IPR.

III. PRECISE RELIEF REQUESTED (37 C.F.R. § 42.22(a) AND IDENTIFICATION OF CHALLENGE (37 C.F.R. § 42.104(b))

The Board should institute IPR and find claims 1-5, 7, and 9-14 of the '686 patent unpatentable under AIA 35 U.S.C. § 103(a) based on the following combinations:

Ground	Combination	Claims
1A	Guo-Hu	1, 3, 4, 9, 10, 12, 13
1B	Guo-Hu-Kakinuma	2, 11
1C	Guo-Hu-Wang	5, 14
1D	Guo-Hu-Kusagawa	7
2A	Tao-Kusagawa	1, 3, 7, 9, 10, 12
2B	Tao-Kusagawa-Kakinuma	2, 11
2C	Tao-Kusagawa-Guo	4, 13
2D	Tao-Kusagawa-Wang	5, 14
3	Guo-Kusagawa	1, 7, 10

The '686 patent claims priority to PCT/CN2020/087515 filed April 28, 2020, its earliest possible priority date. All applied art qualifies under at least § 102(a)(1).

This Petition is supported by the expert declaration of Yu Zhu, Ph.D., an expert in the field of battery materials, electrode architectures, and related processing and manufacturing considerations. EX1003, ¶¶1-37.

IV. PERSON OF ORDINARY SKILL IN THE ART (“POSA”)

A POSA at the time of the patent’s effective filing date would have had at least an undergraduate degree in chemistry, chemical engineering, polymer science and engineering, or materials science and engineering and two years of work experience in the field of battery materials and construction. A higher level of education, such as a master’s degree in one of these fields, could substitute for work experience. EX1003, ¶¶17-21.

V. BACKGROUND OF THE ART

Well before 2020, high-capacity electrochemical devices, such as lithium-ion (“Li-ion”) batteries, were widely used and included a positive electrode, a negative electrode, and a separator between them. The negative electrode included a negative current collector, a negative active material layer, and various additives and binders. It was also well known that negative electrode materials for lithium-ion batteries normally used graphite. EX1016, 21; EX1015, 11444; EX1008, ¶3; EX1007, ¶38. However, it was an art-recognized problem that graphite-based negative electrode active materials had limited capacity. EX1008, ¶4; EX1016, 21; EX1015, 11445; EX1003, ¶¶39-40.

One well-known solution to the limited capacity of graphite was to include silicon in the negative electrode active material. EX1015, 11455; EX1016, Abstract, 21-22; EX1008, ¶4. Indeed, the art taught that “silicon materials, such as

silicon and silicon oxide, having a higher capacity than carbon materials have recently attracted more attention as negative electrode active materials of non-aqueous electrolyte secondary batteries.” EX1008, ¶4; EX1016, Abstract, 21 (“Si is considered one of the most promising materials [for lithium ion negative electrode batteries] because of its exceptionally high specific capacity”); EX1003, ¶¶41-42.

However, the art also recognized that silicon presented its own drawbacks: specifically, silicon was known to exhibit “huge volume variation” when charging and discharging, “undergo[ing] larger expansion and shrinkage with charging and discharging than carbon materials.” EX1016, 21; EX1008, ¶5.

Indeed, “[t]o overcome this problem [with expansion and shrinkage] the most successful strategy is to incorporate other components (metals, oxides, carbon, polymer) which act as stress buffering matrices into Si which can accommodate the strain, especially the carbon medium.” EX1016, 21-22. Thus, it was known that anode active materials containing a mixture of both carbon and silicon would provide a balance between the advantages and shortcomings of both materials. *Id.*; EX1008, ¶66. In fact, a POSA had a rough idea of the optimal balance between carbon and silicon in such composite active materials. *Id.* (“The silicon material present in an amount of 3% by mass or more can improve the load

characteristic of the non-aqueous electrolyte secondary battery.”); EX1003, ¶¶43-45.

It was also known before 2020 that the number of tabs, their relative locations along the edge of the electrode, the thicknesses of the electrode layers, and the various distances among them were all well-understood principles of battery geometry. EX1014, 70, 71, 73, 78. It was also generally understood how differences in battery geometry could influence the performance, energy density, and reliability of the resulting battery. *Id.* Additionally, it was well-known before 2020 that a single, centered tab can reduce internal resistance. EX1003, ¶¶46-49, *citing* EX1009, Abstract.

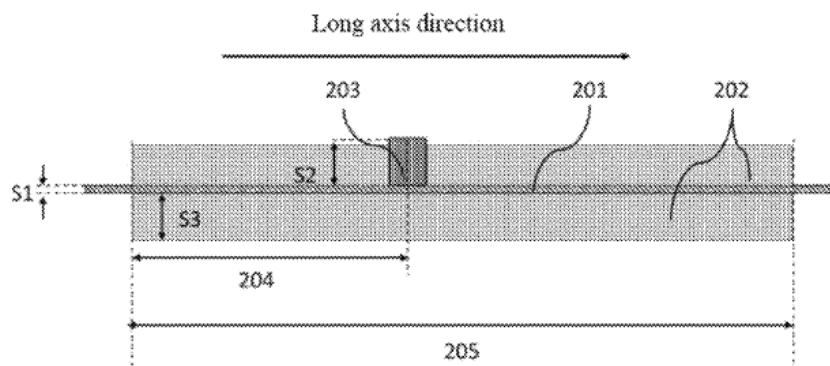
VI. THE '686 PATENT

The '686 patent is directed to an electrochemical apparatus (such as a lithium-ion battery) with a recited negative electrode arrangement and active material composition. EX1001, Abstract, 1:25-30. The '686 patent described its electrochemical apparatus as follows:

As shown in FIG. 4 and FIG. 5, this application provides “a negative electrode, including: a negative current collector 201, a negative active material layer 202, and a negative tab 203. The negative tab 203 is arranged on a side edge of a long axis of the negative current collector 201 and is in contact with the negative active material layer 202. The negative active material layer 202 contains a silicon-based material, a distance between a central position of the negative tab 203

and either end of the negative active material layer 202 in a long axis direction is a first length 204, and a length of a long axis of the negative active material layer is a second length 205.

EX1001, 4:50-63. The '686 patent further describes the composition of its negative active material as limited by the equation $0.5 \geq D \geq 0.6 \times G$, wherein D is a ratio of the first length 204 to the second length 205, and G is a weight percentage of the silicon-based material in the negative active material. EX1001, 4:66-5:1. This electrochemical apparatus is depicted in Fig. 4:



EX1001, Fig. 4.

The '686 patent describes that its electrochemical apparatus exhibits “lower direct current resistance and better discharge rate, and also shows better cycle capacity” as a result of its silicon content. EX1001, 16:60-67. It also states that by arranging the negative tab position and controlling the silicon content, the “safety performance of the electrochemical apparatus” is increased. *Id.*

A. Prosecution History

The '686 patent issued from U.S. Appl. No. 17/699,555 filed March 21, 2022, which claimed benefit as a continuation of PCT/CN2020/087515 filed April 28, 2020. The '555 application was filed with 14 original claims. EX1002, 1-11, 39-41.

The Examiner issued a first Non-Final Office Action on September 23, 2024. EX1002, 634-42. In that first Office Action, the Examiner allowed claims 1, 3, 5-9, 10, and 14, and rejected claims 2, 4, and 11-13 under 35 U.S.C. § 112(b). EX1002, 636-41.

Although Applicant listed over 30 patents, patent applications, and literature documents (EX1002, 596-605) in two IDSs, the Examiner cited only one Foreign Patent Document (JP-2016122628-A to Takano, or “Takano,” EX1006) and one Non-Patent Document (Takano abstract) during prosecution. In this context, the Examiner alleged that only a single limitation—“negative tab 23 is arranged on a side edge of a long axis of the negative current collector”—was taught in the art. EX1002, 640. The Examiner then alleged that Takano did not teach or suggest any of the remaining claim elements from claims 1 or 10 and stated that “the instant claims are patentably distinct from the prior art of record” as a result. *Id.*

On December 20, 2024, Applicant submitted an Amendment and Reply amending claims 2, 4, and 11-13 consistent with the Examiner’s recommendations.

EX1002, 833-38. On March 25, 2025, the Office issued a Notice of Allowance without providing reasons for allowance. EX1002, 845-49.

VII. CLAIM CONSTRUCTION

Petitioner does not believe any claim terms require specific construction and thus should receive their plain and ordinary meaning, in the context of the '686 patent specification, under *Phillips*. Under any reasonable construction, the challenged claims are unpatentable.

VIII. APPLIED PRIOR ART REFERENCES

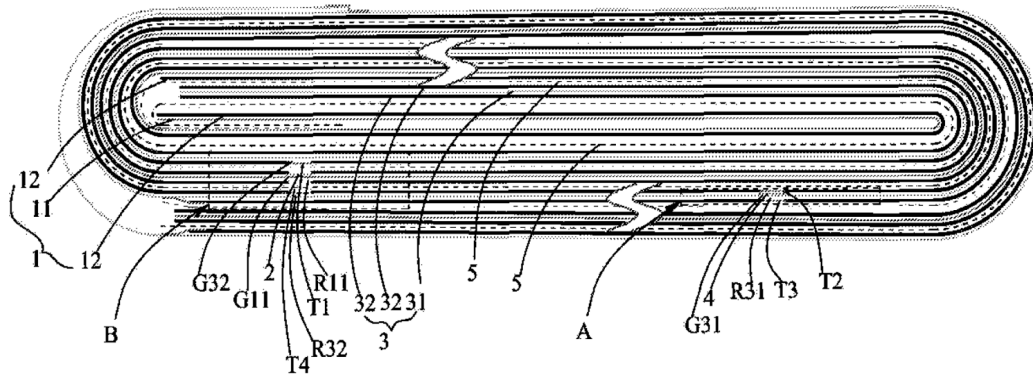
A. Guo

Guo discloses a secondary battery cell that includes anode-tab- and cathode-tab-accommodating grooves, which Guo states improves energy density and safety performance of the secondary battery. EX1011, ¶¶4-7; EX1003, ¶66.

Guo's secondary battery cell is an electrochemical apparatuses comprising: a positive electrode ("cathode sheet"), a separator ("separator"), and a negative electrode ("anode sheet") (EX1011, Abstract), wherein the negative electrode comprises a negative current collector ("anode current collector"), a negative active material layer ("anode membrane"), and a negative tab ("anode tab") (EX1011, ¶66). EX1003, ¶67.

Guo also discloses a wound electrochemical apparatus. EX1011, ¶8; Fig. 1. Guo illustrates a negative electrode ("anode sheet 1") and positive electrode ("cathode sheet 3") separated by a separator ("separator 5") in a "wound-formed"

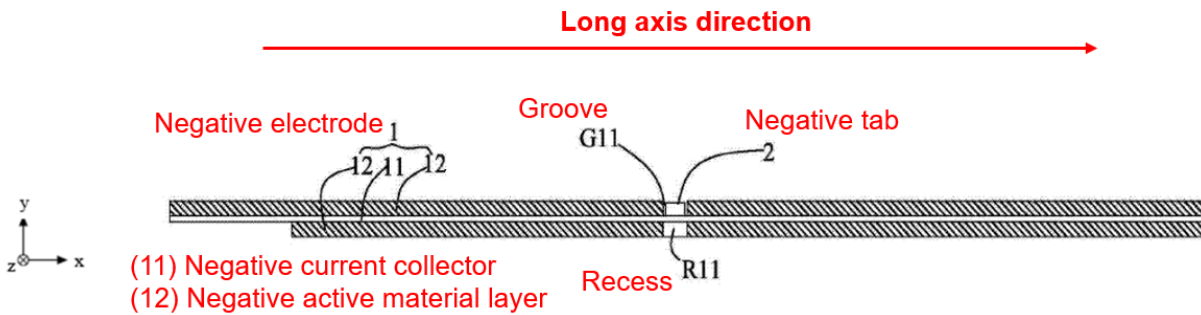
geometry, as shown in Guo's Figure 1:



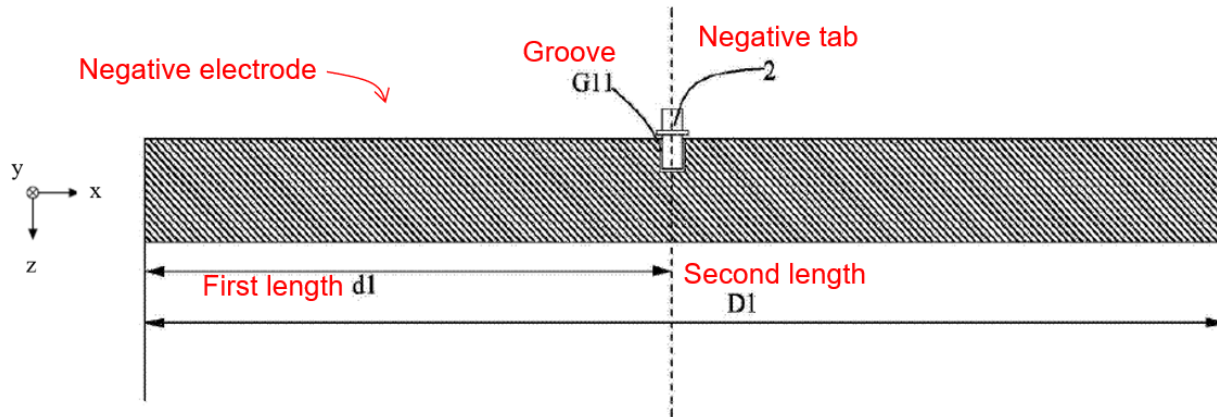
EX1011, FIG. 1

EX1003, ¶¶68-69.

Guo Figs. 3a/3b (annotated) present the negative current collector, negative active material layer, and negative tab components.



EX1011, FIG. 3a (annotated)



EX1011, FIG. 3b (annotated)

EX1003, ¶70.

B. Hu

Hu discloses a lithium-ion battery (EX1005, ¶6) comprising: a positive electrode (“positive electrode sheet”), a separator (“separator”), and a negative electrode (“negative electrode sheet”) (*id.*, Abstract, Claim 1, ¶37), wherein the negative electrode comprises a negative current collector (“current collector”) (*id.*, ¶4), a negative active material layer (“negative electrode active material”) (*id.*, ¶14), and a negative tab (“negative electrode tab”) (*id.*, ¶20). EX1003, ¶72.

Hu’s battery includes a negative electrode with a negative active material containing a silicon-based material, which improves shear stability of the negative active material, and tab positioning that reduces the battery’s internal resistance.

EX1005, ¶¶14-19, 23-28; EX1003, ¶71.

C. Kakinuma

Kakinuma discloses a cylindrical battery that comprises: a positive electrode (“positive electrode plate,” EX1010, ¶¶51-52, 62-64), a separator (“separator,” *id.*, ¶¶51, 73-75), and a negative electrode (“negative electrode plate,” *id.*, ¶¶51, 92-94), wherein the negative electrode comprises a negative current collector (“negative electrode core material,” *id.*, ¶¶53, 57, 94), a negative active material layer (“negative electrode mixture slurry,” *id.*, ¶¶93-94), and a negative tab (“negative electrode lead,” *id.*, ¶¶53, 98-99). EX1003, ¶¶73-74. Kakinuma discloses preferred thicknesses for the negative current collector, the negative tab, and the negative active material layer. EX1010, ¶¶53, 57; EX1003, ¶74.

D. Kusagawa

Kusagawa discloses a secondary battery (EX1008, Abstract, ¶16) comprising: a positive electrode (“positive electrode plate,” *id.*, Abstract, ¶¶16, 32), a separator (*id.*, ¶¶16, 34), and a negative electrode (“negative electrode plate,” *id.*, Abstract, ¶¶16, 27-28), wherein the negative electrode comprises a negative current collector (“negative electrode current collector,” *id.*, Abstract, ¶¶16, 28), a negative active material layer (“negative electrode mixture layer,” *id.*, Abstract, ¶¶16, 28), and a negative tab (“negative electrode tab” *id.*, Abstract, ¶¶16, 28). EX1003, ¶75.

Kusagawa teaches using a silicon material and graphite as negative electrode active materials, which provide “high capacity and a good load characteristic.” EX1008, ¶15. In this context, Kusagawa Example 1 presents a negative electrode active material comprising SiO (4% by mass) and graphite, which performed favorably with respect to comparative examples without any silicon material. EX1008, ¶¶26, 54-58, Table 1. Kusagawa Example 15, which is related to Example 1, discloses a negative electrode active material comprising 4% silicon-graphite composite by mass, where silicon particles and graphite particles are bonded to each other with amorphous carbon. *Id.* at ¶¶42-43; EX1003, ¶75.

E. Tao

Tao is directed to a lithium-ion battery that comprises a positive electrode, a separator, and a negative electrode, wherein the negative electrode comprises a negative current collector, a negative active material layer, and a negative tab. EX1007, ¶¶2, 8, Fig. 4; EX1003, ¶¶351-56, 360. Tao teaches compositions and arrangements of negative electrodes, specifically, a “negative plate having a negative film” that also comprises a negative lead (i.e., negative tab) soldered in a recess in the middle of this negative film (i.e., negative active material). EX1007, Abstract; EX1003, ¶¶360-62. Tao teaches that its battery exhibits positive characteristics such as increased safety metrics, improved battery life, and improved energy density. EX1007, Abstract. Tao teaches that modern demands on

lithium-ion batteries require reduced battery thickness and increased energy density, and the batteries of its disclosure achieve this goal through control of the negative electrode components' arrangement. *Id.* at ¶¶3, 9, 14, 20; EX1003, ¶¶76-77.

Tao teaches several active material compositions. *Id.* at Examples 1-5; EX1003, ¶78. One such active material composition is a graphite-based composition comprising “95 wt % negative active material graphite, 2 wt % bonding agent SBR, 1 wt % thickener CMC and 2 wt % conductive agent graphite in solvent deionized water.” EX1007, ¶38. Once the active material composition is coated on copper foil, a portion of active material is removed at a “middle portion” of the plate to form a recess. *Id.* at ¶38. A negative tab (called a “lead”) is soldered into the recess to form the negative plate. EX1007, ¶¶8-9.

Tao also teaches a negative active material composition in Example 2 that “is almost the same as Example 1, except that: ... The negative active material is silicon.” *Id.* at ¶¶41, 47; EX1003, ¶79. As such, in Example 2, Tao teaches a negative active material that is 95 wt % silicon, 2 wt % bonding agent SBR, 1 wt % thickener CMC and 2 wt % conductive agent graphite in solvent deionized water. EX1007, ¶¶41, 47; *id.* at Example 3, ¶54 (describing another silicon-based negative active material composition). Tao states “the safety performance of the lithium ion battery” is “improved remarkably” for Examples 1-3. *Id.* at Table 1,

¶73. Tao also shows that “the structure of the positive plate and negative plate according to the present invention” overcome challenges with uneven battery thickness and improve battery capacity, energy density, and internal resistance. *Id.* at Table 2, ¶75.

When using silicon in its negative active material, Tao teaches: “[a]s clearly shown in Table 3, if the negative active material for use in the negative plate 2 is apt to serious volume expansion, such as silicon,” the battery can become deformed. *Id.* at ¶77, Table 3; EX1003, ¶80. Tao teaches that a way to solve this problem is with its electrode recess arrangements, which it describes as improving the known issue of silicon expansion. EX1001, ¶¶77-80.

F. Wang

Wang teaches that its wound battery cell configuration improves energy density, reduces cost, and reduces the risk of cell deformation. EX1012, Title, ¶¶8, 20, 48; EX1003, ¶81.

Wang’s wound battery cell comprises: a positive electrode (“second electrode plate,” EX1012, Abstract, ¶¶8, 48), a separator (“first separator” and “second separator,” EX1012, Abstract, ¶¶8, 48), and a negative electrode (“first electrode plate,” EX1012, Abstract, ¶8, 48), wherein the negative electrode comprises a negative current collector (“first current collector,” EX1012, ¶¶8, 49),

a negative active material layer (“first active material layer,” EX1012, Abstract, ¶8, 49), and a negative tab (“first electrode tab,” EX1012, ¶¶8, 9, 49). EX1003, ¶82.

IX. GROUND 1A: CLAIMS 1, 3, 4, 9, 10, 12 AND 13 WOULD HAVE BEEN OBVIOUS OVER GUO AND HU

A. Motivation to Combine (MTC)

Guo and Hu are analogous art to each other and the ’686 patent (“analogous”)—both describe very similar electrochemical apparatuses for use in electronic products. Each apparatus comprises a positive electrode, a separator, and a negative electrode, wherein the negative electrode comprises a negative current collector, a negative active material layer, and a negative tab. EX1011, Abstract, ¶¶44-47, 66; EX1005, Abstract, Claim 1, ¶¶4, 14, 20, 37; EX1003, ¶83.

Thus, Guo and Hu each disclose most limitations recited in the claims of the ’686 patent. *Id.* When considering these similar batteries, a POSA would have been motivated to combine or insert specific features in components of the batteries from Hu into Guo’s battery, such as in the negative electrode and its negative active material layer. EX1003, ¶¶118-24. A POSA would have been motivated to do this, for instance, with the goal of creating batteries having “higher energy density” and “higher safety.” EX1003, ¶¶85 (citing EX1011, ¶¶4, 79; EX1005, Abstract, ¶33), 120. Moreover, because of their notable similarities, a POSA would have understood that the geometries of the batteries disclosed in Guo and Hu were compatible and would have had a reasonable expectation of success in combining

the teachings in these references. EX1003, ¶¶84 (citing EX1005, ¶5), 120-22 (citing EX1005, ¶19).

Guo discloses nearly all limitations recited in '686 patent claims 1, 4, 9, 10, and 13. Guo's negative tab is arranged on a side edge of a long axis of the negative current collector (EX1003, ¶¶127-30), with the recited first (EX1003, ¶¶131-36) and second (EX1003, ¶¶137-39) lengths.

Guo does not expressly disclose a silicon-based material as part of its negative active material (as recited in claims 1, 3, 10, 12)—namely because Guo does not provide this level of detail—but Hu does. EX1003, ¶¶109-17, 140-47.

Hu explicitly describes what material to use in a negative electrode material within a lithium battery. Hu discloses a negative active material layer containing a silicon-based material having weight range of less than or equal to 70%. EX1003, ¶¶112-17, 159-65.

Hu also teaches a silicon-based material containing at least one of an elementary substance of silicon, a compound of silicon, an alloy of silicon, or a silica material (claims 3 and 12). *Id.*; EX1003, ¶¶176-181.

Because details regarding the composition of its negative active layer material (e.g., containing a silicon-based material) were not expressed in Guo (EX1003, ¶¶109-11), a POSA would have looked to Hu to fill in that information, especially because Hu described the benefits of using its silicon-based material.

EX1003, ¶¶85, 120 (citing EX1005, Abstract, ¶¶14-19, 4, 33). Hu describes a negative electrode active material comprising a negative electrode binder that can “reduce internal pressure of the battery” and “improve the battery’s cycling performance” without “swelling, loosening, or powder shedding.” EX1005, ¶¶14-19, 4; EX1003, ¶120.

Hu explicitly describes details regarding what material to use in a negative electrode material within a lithium battery. EX1003, ¶¶112-17. A POSA would have found it obvious how to add the teachings of Hu to Guo because Hu (1) explicitly describes how to add nano-SiO₂ and the silane coupling agent to its styrene-butadiene rubber emulsion, and (2) provides a preferred particle size range for the nano-SiO₂. *Id.* at ¶119 (citing EX1005, ¶¶17-19, 40, 49, 58). Similarly, a POSA would have understood how to add the *specific weight percentages* of Hu’s silicon-based material to Guo’s negative active material layer in view of teachings in Hu and a skill set well within that of a POSA. *Id.*

When doing so, the first and lengths in the battery as presented in Guo, and the negative active material layer comprising silicon as taught in Hu, would have satisfied the “relationship formula (I)” of $0.5 \geq D \geq 0.6 \times G$ also recited in claims 1 and 10. EX1003, ¶¶140-65, 209-13.

Thus, Guo in view of Hu disclosed and rendered obvious claims 1, 3, 4, 9, 10, 12, and 13. EX1003, ¶¶86-87.

B. Independent Claims 1 and 10

1. [1.P]/[10.P]/[1.1]/[10.1]/[1.2]/[10.2]/[1.3]/[10.3]

Guo discloses “lithium-ion batteries” “widely used in various electronic products” and also “electrochemical energy storage devices, and more particularly to a secondary battery cell.” EX1011, ¶¶1-2. Guo’s secondary battery cell is an “electrochemical apparatus,” and Guo’s electronic product is an “electronic apparatus comprising an electrochemical apparatus.” EX1003, ¶¶88-89, 195-98.

Guo also describes “a secondary battery cell, comprising an anode sheet, an anode tab, a cathode sheet, a cathode tab, and a separator.” EX1011, ¶5. A POSA would recognize these terms were commonly used in the art to describe a negative electrode, a negative tab, a positive electrode, a positive tab, and a separator, respectively, as recited in claims 1 and 10. EX1003, ¶¶90-99, 199-201.

2. [1.4]/[10.4]/[1.5.1]/[10.5.1]

Guo discloses a battery comprising a negative electrode with “an anode current collector.” EX1011, ¶5. Guo states that “the anode sheet is formed with an anode tab accommodating groove, the bottom of which is an **anode current collector** and the peripheral side of which is an anode membrane, and the anode tab is accommodated within the anode tab accommodating groove and is electrically connected to the anode current collector at the anode tab accommodating groove.” *Id.* A POSA would interpret this description as disclosing a negative electrode comprising a negative current collector. EX1003, ¶¶100-03,

202.

A POSA also would recognize the arrangement of elements within Guo Fig. 3a as teaching a negative electrode comprising a negative current collector with a negative active material layer disposed on the negative current collector. EX1003, ¶105; EX1011, ¶¶5, 10, 74. Guo describes forming an anode membrane by “applying and drying the anode membrane slurry.” EX1011, ¶69. A POSA would recognize this language as a description of a common method for forming a negative active material layer. EX1003, ¶107 (citing EX1019, ¶¶26, 42, 54), 507 (citing EX1018, Abstract, ¶1). Thus, Guo’s anode membrane is a “negative active material layer.” EX1003, ¶¶104-08, 203.

3. [1.5.2]/[10.5.2]

Guo does not expressly disclose a silicon-based material as part of its negative active material because it focuses on the overall battery structure rather than specific electrode material composition. EX1003, ¶¶109-111; EX1011, ¶79.

Accordingly, Guo leaves the selection of suitable negative active materials to a POSA. EX1003, ¶110. A POSA would have understood that conventional and known active materials could be used in Guo’s battery structure, including materials taught in Hu. EX1003, ¶111.

Hu discloses a lithium-ion battery comprising a “negative electrode active material” coated on a “negative electrode sheet.” EX1005, ¶8. A POSA would

have recognized that Hu's "negative electrode active material" as the material formulation forming a negative active material layer when coated on a current collector. EX1003, ¶¶112-13. Hu discloses "[p]referably, the negative electrode active material comprises the following components in mass percentage: sodium carboxymethyl cellulose (CMC) 1.5-1.7%, conductive carbon black 1.4-1.6%, graphite 94.6-95.1%, styrene-butadiene emulsion 1.9-2.1%." EX1005, ¶14.

Hu additionally discloses that the styrene-butadiene emulsion optionally includes silicon-based materials, namely nano-SiO₂ (0.6–1.3 wt%) and a silane coupling agent (0.2–0.8 wt%). EX1005, ¶16. SiO₂ is a silicon-based material, and silane coupling agents include silicon-containing functional groups. EX1003, ¶115 (citing EX1017, 3-5; EX1020, 1). Thus, Hu expressly teaches silicon-based materials within the negative electrode active material system. Based on Hu's disclosure, the silicon-based material content within the emulsion ranges from 0.8 wt% to 2.1 wt% (0.6–1.3% SiO₂ plus 0.2–0.8% silane). EX1005, ¶16.

Because the styrene-butadiene emulsion is present at 1.9–2.1 wt% of the negative electrode active material, the resulting silicon-based material content in the overall negative electrode active material is approximately 0.0152 wt% to 0.0441 wt% (i.e., 0.8%×1.9% to 2.1%×2.1%). EX1003, ¶114.

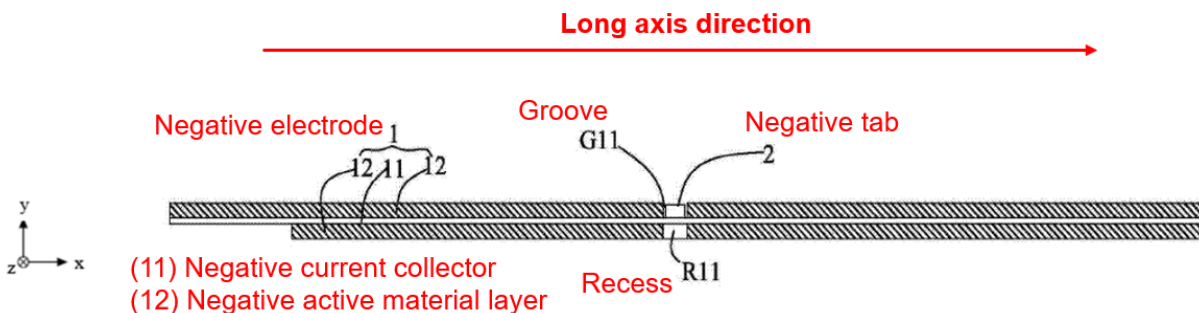
A POSA would have understood that Hu's negative electrode active material thus includes a silicon-based material within the active material layer as recited in

the challenged claims. EX1003, ¶¶112-117, 204.

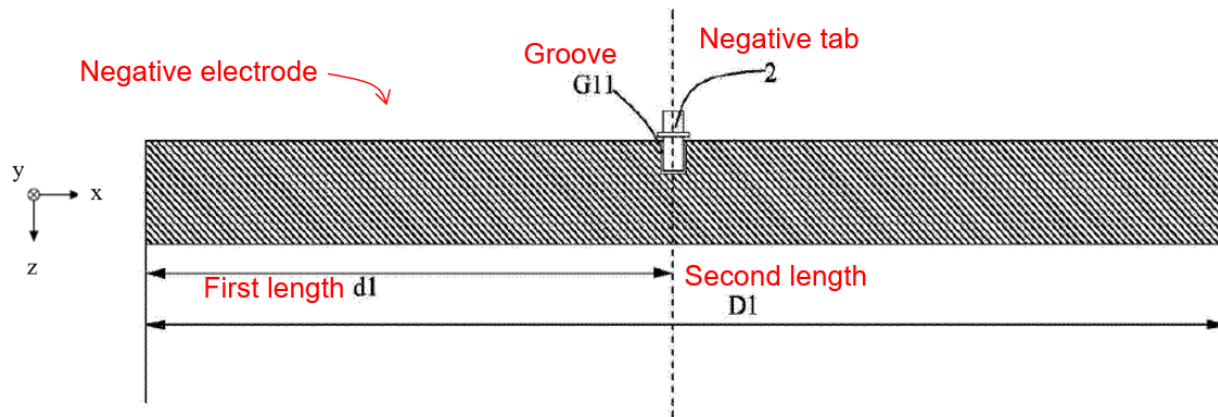
A POSA would have been motivated to combine Hu's silicon-containing negative electrode active material with Guo's battery structure because Guo is directed to battery architecture without specifying active material composition, and Hu provides detailed compositions that improve electrode stability and safety performance. EX1003, ¶¶118-20; EX1005, ¶¶17-19, 40, 49, 58. In particular, Hu teaches that its binder system reduces internal pressure and prevents swelling, loosening, and powder shedding, which a POSA would have understood as improved safety-related performance. EX1005, ¶¶14-19. Accordingly, Hu with Guo was obvious and had a reasonable expectation of success. EX1003, ¶¶121-24.

4. [1.6.1]/[10.6.1]/[1.6.2]/[10.6.2]

Guo Figs. 3a/3b (annotated) show the different components of Guo's anode sheet 1 ("negative electrode") comprising an anode membrane 12 ("negative active material layer") and the locations of those components in relation to each other, including its anode tab 2 ("negative tab"). EX1003, ¶126, citing EX1011, ¶66.



EX1011, FIG. 3a (annotated).



EX1011, FIG. 3b (annotated).

Guo Figs. 3a/3b disclose an anode sheet formed with “an anode matching recess R11 located on the opposite back side of the anode tab accommodating groove G11, the bottom of the anode matching recess being an anode current collector 11, and the peripheral side thereof being an anode membrane 12.”

EX1011, ¶66. The anode current collector is a “negative current collector,” and the anode tab is a “negative tab.” EX1003, ¶¶125-26. As shown in Guo Figs. 3a/3b, the anode current collector 11 extends in a longitudinal direction, which a POSA would have understood as defining a long axis of the negative current collector. EX1003, ¶129. In particular, Figs. 3a/3b illustrate this long axis is aligned with the x-direction. *Id.*

Guo discloses a negative tab arranged on a side edge of a long axis of a negative current collector. EX1003, ¶¶127-30. Specifically, anode tab 2 is positioned at an edge region of the anode sheet relative to the longitudinal direction

of the anode current collector 11. *Id.* at ¶129. Figs. 3a/3b thus show that negative tab 2 is located at a lateral side edge of the anode sheet, i.e., normal to the x-direction. *Id.* at ¶129. Accordingly, Guo illustrates a negative current collector with a long axis (i.e. aligned with an x-direction), wherein a negative tab is arranged on a side edge of the long axis (i.e. normal to the x-direction). *Id.*, *Id.* at ¶¶205-06.

5. [1.6.3]/[10.6.3]

Guo's negative tab in Figs. 3a/3b discloses a first length, which is a distance between a central position of the negative tab and either end of the negative active material layer in a long axis direction. EX1003, ¶131. Regarding the first length, Guo notes that **“the distance between the center line of the anode tab accommodating groove G11 and the head of the anode sheet 1 is defined as d1.”** EX1011, ¶74 (emphasis added). Guo notes that “anode tab 2 is accommodated within the anode tab accommodating groove G11,” and notes that “anode tab 2 can be electrically connected to the anode current collector 11 at the anode tab accommodating groove G11.” EX1011, ¶¶46, 49, 55; EX1003, ¶132.

A POSA would have understood that anode tab 2 is positioned centrally within the anode tab accommodating groove G11, such that the center line of anode tab 2 is aligned with the center line of the groove G11. EX1003, ¶132. This is supported by Guo Fig. 3b, which illustrates anode tab 2 centered within groove G11. EX1003, ¶132; EX1011, Fig. 3b.

Figs. 3a/3b show the length of the negative current collector matches the length of the upper layer of anode membrane 12 (the negative active material layer) along the long axis. The negative electrode and the upper negative active material layer are aligned and have the same length, so the **distance d1 can be defined relative to a negative active material layer**. EX1003, ¶134. Because d1 is aligned with the defined long axis direction, a POSA would have understood Guo's "d1" to be a "distance between the center line of the negative tab and an end of the negative active material layer in a long axis direction." EX1003, ¶¶133-136, 207.

6. [1.6.4]/[10.6.4]

Regarding a second length, Guo notes "the distance from the head to the tail of the anode sheet 1 is defined as D1." EX1011, ¶74. Guo Figs. 3a/3b show distance D1 is aligned with the defined long axis direction. And Figs. 3a/3b show length of the negative current collector matches length of the upper negative active material layer along the long axis in Fig. 3a. EX1003, ¶¶137-139. Negative electrode and the upper negative active material layer are aligned and have the same length, so **the distance D1 can be defined relative to the negative active material layer**, i.e. the distance from the head to the tail of the negative active material layer. *Id.* **D1 is equivalent to a length of a long axis of the negative**

active material layer. i.e., the “second length” recited in claims 1 and 10. *Id.*, ¶208.

7. [1.7.1]/[10.7.1]/[1.7.2]/[10.7.2]/[1.7.3]/[10.7.3]/[1.7.4]/[10.7.4]

Guo Fig. 3b shows “d1” is defined as “the distance between the center line of the anode tab accommodating groove G11 and the head of the anode sheet,” with “d1 being within the range of 1/10 D1 to 7/10 D1 calculated from the head of the anode sheet.” EX1011, ¶74; EX1003, ¶156. Guo further explains that this arrangement helps “reduce the direct current resistance (DCR) of the secondary battery cell,” and that “the closer d1 is to the middle position of the anode sheet 1 (i.e., 1/2 D1), the smaller the DCR.” EX1011, ¶74. Thus, a POSA looking to reduce DCR would have understood Guo to teach placing the anode tab accommodating groove G11 at a position of $d1 = (D1)/2$. In view of Guo’s Figs. 3a/3b, a POSA likewise would have understood the negative tab to be positioned at $d1 = (D1)/2$. EX1003, ¶¶152-55. As shown in annotated Guo Fig. 3b (EX1003, ¶155) the “first length” (d1) disclosed in Guo is equal to $(D1)/2$. EX1003, ¶156. The “second length” is equal to D1. EX1003, ¶137. Accordingly, the ratio (D) of the first length to the second length is $((D1)/2)/(D1) = 0.5$. *Id.* at ¶¶157-58.

With regard to “G,” as noted, Guo does not expressly disclose a silicon-based material as part of its negative active material, but Hu does. EX1003, ¶159.

Hu discloses a negative active material layer containing a silicon-based material. EX1003, ¶¶112-14, 159, 164. Specifically, the calculated weight percentage of silicon-based material (G) in Hu ranges from 0.0152% ($0.8\% \times 1.9\%$) to 0.0441% ($2.1\% \times 2.1\%$). Section VII.B.2. EX1003, ¶¶160-61. This calculated range is less than or equal to 70%, thereby satisfying limitations [1.7.4]/[10.7.4]. EX1003, ¶¶162-165.

Substituting these values into formula (I) confirms that the claimed relationship is satisfied. Using Hu's lower value of G (0.0152%), $0.6 \times G$ is $0.6 \times 0.0152\% = 0.00912\%$ (0.0000912 when expressed as a fraction of 1). EX1003, ¶160. Substituting $0.6 \times G = 0.0000912$ (as disclosed in Hu) and $D = 0.5$ (as disclosed in Guo) into formula (I) yields: $0.5 \geq 0.5 \geq 0.0000912$, which satisfies formula (I). EX1003, ¶¶140-51. Using Hu's upper value of G (0.0441%), $0.6 \times G$ is $0.6 \times 0.0441\% = 0.02646\%$ (0.0002624 when expressed as a fraction of 1). EX1003, ¶147. Substitution of $0.6 \times G = 0.0002624$ (as disclosed in Hu) and $D = 0.5$ (as disclosed in Guo) into formula (I) yields: $0.5 \geq 0.5 \geq 0.0002624$, which also satisfies formula (I). *Id* at ¶¶148, 209-13.

8. Guo-Hu Combination

A POSA would have been motivated to use the amounts of silicon-based material disclosed in Hu as part of a negative active material layer in the battery disclosed in Guo to produce a battery with reduced direct current resistance and

improved safety performance. EX1011, ¶¶4, 74; EX1005, ¶¶4, 14-19 (describing negative electrode active material comprising a negative electrode binder that can “reduce internal pressure of the battery” and “improve the battery’s cycling performance” without “swelling, loosening, or powder shedding”); EX1003, ¶¶170-75, 120. Moreover, POSA would have understood how to combine these references for *any* specific weight percentage of silicon-based material, including a weight percentage of silicon-based material less than or equal to 70%. EX1003, ¶¶119, 166-68.

In addition, a POSA would have recognized that Hu discloses a negative tab position relative to the position of the negative electrode, and this teaching of Hu emphasizes its compatibility with Guo. EX1003, ¶¶169-75; EX1005, ¶27. A POSA would have recognized that centering a negative active material layer within a negative electrode is a configuration well-known in the art (as taught in Guo), and in this known configuration, a negative tab centered within the negative electrode results in the negative tab being centered within the negative active material layer. EX1003, ¶172 (citing EX1011, Fig. 3b). A POSA therefore would have recognized that Hu’s teachings of including a silicon-based material in the negative active material layer would have been compatible with the battery disclosed in Guo. EX1003, ¶¶172-75.

C. Claims 3 and 12

Hu's silicon-based materials are nano SiO₂ and silane coupling agent, which meet limitations recited in claims 3 and 12. EX1005, ¶16; EX1003, ¶¶115, 176-81, 214-16.

D. Claims 4 and 13

Guo shows that the length of the negative current collector ("D1") matches the length of the upper negative active material layer (the claimed "second length") along a long axis (i.e. the x-axis) in Fig. 3a, which results in "a ratio of the second length to a length of the long axis of the negative current collector" of 1, i.e., a ratio of 0.8 to 1.0, as recited in claims 4 and 13. EX1003, ¶¶182-85, 217-18.

E. Claim 9

Guo claim 1 recites: "*the anode tab (2) is accommodated within the anode tab accommodating groove.*" EX1011, claim 1 (emphasis added); *see also, id.* at ¶66; EX1003, ¶¶186-93. Guo Figs. 3a/3b show that the anode tab (i.e., negative tab) is arranged in the groove, as recited in claim 9. EX1003, ¶¶192-94.

X. GROUND 1B: CLAIMS 2 AND 11 WOULD HAVE BEEN OBVIOUS OVER GUO, HU, AND KAKINUMA

A. MTC

Kakinuma, Guo, and Hu are analogous art because all are directed to the construction of similar electrochemical apparatuses that have many components in common. Much like Guo and Hu, the electrochemical apparatus ("cylindrical

battery,” EX1010, Abstract) of Kakinuma comprises: a positive electrode (“positive electrode plate,” *id.* at ¶¶51-52, 62-64), a separator (“separator,” *id.* at ¶¶51, 73-75), and a negative electrode (“negative electrode plate,” *id.* at ¶¶51, 92-94), wherein the negative electrode comprises a negative current collector (“negative electrode core material,” *id.* at ¶¶53, 57, 94), a negative active material layer (“negative electrode mixture slurry,” *id.* at ¶¶93-94), and a negative tab (“negative electrode lead,” *id.* at ¶¶53, 98-99). EX1003, ¶220.

Furthermore, just as the ’686 patent describes the need for an electrochemical apparatus “to have higher energy density,” and “higher safety” (EX1001, 1:27-28), and just as Guo and Hu disclose goals of improving energy density and safety (EX1011, ¶¶4, 79; EX1005, Abstract, ¶33), Kakinuma states a need for improved energy density and “enhanced ... safety.” EX1010, Abstract, ¶¶3, 10, 11, 15, 17, 20, 32, 39; EX1003, ¶¶219, 221.

A POSA would have started with the battery presented in Guo, knowing that Guo does not teach all relevant details as it relates to certain components. A POSA would have looked to Hu and Kakinuma for relevant specific details, including to improve the performance of Guo’s battery for the reasons taught in Hu and Kakinuma. EX1003, ¶¶222-25.

Claims 2 and 11 recite thicknesses of three components of the battery: the negative current collector (S_1), the negative tab (S_2), and negative active material

layer (S_3). They also recite that the negative electrode satisfies the “relationship formula (II): $0.9 \times (S_1 + 2S_3) \leq S_1 + S_2 \leq 1.1 \times (S_1 + 2S_3)$.”

Guo provides values for S_2 and S_3 (but not S_1) for its battery, and Hu does not explicitly provide values for S_1 , S_2 , or S_3 . EX1003, ¶¶226-228. However, while Guo-Hu does not disclose all values for the relationship formula (II), a negative electrode satisfying formula (II) was well known in the prior art, as taught by Kakinuma. EX1003, ¶¶229, 243-44, 250-51, 257-60.

Because both Guo and Hu are silent on the S_1 value, a POSA would have looked to other prior art that had all three thickness values disclosed in a well-performing battery embodiment. EX1003, ¶233. One such reference is Kakinuma. A POSA would have known to look to Kakinuma to address any lack of information or shortcoming in Guo-Hu. *Id.* Kakinuma praises its electrode assembly, stating “[w]ith such an electrode assembly 5, the reaction area is increased, which can achieve strong load characteristics,” and included its components, such as the negative electrode plate (i.e., negative electrode with active material), to “increase battery capacity.” EX1010, ¶¶51-52; EX1003, ¶234. Thus, a POSA would have been motivated to engage in routine optimization and incorporate the electrode component thicknesses disclosed in Kakinuma into the apparatus of Guo-Hu, including to achieve the benefits described in Kakinuma. EX1003, ¶¶234-36.

Kakinuma (1) provides a *clear rationale* for its S_1 , S_2 , and S_3 values, (2) describes in detail *how* a POSA would do so for various embodiments (EX1010, ¶¶56-57, 94), and (3) describes in detail *why* its disclosed dimensions would result in an advantageous electrochemical apparatus. EX1003, ¶¶230-39. Moreover, modification to thicknesses only represents a modification in degree, rather than in kind, and would not have been unpredictable to a POSA. EX1003, ¶239. Thus, Kakinuma provided a reasonable expectation of success in generating the subject matter of claims 2 and 11. EX1003, ¶¶237-39, 269.

B. Claims 2 and 11:

1. [2.1.2]/[11.1.2]/[2.2]/[11.2]/[2.1.3]/[11.1.3]/[2.1.4]/[11.1.4]

Because Guo-Hu is silent on a S_1 value, a POSA would have looked to prior art that had all three thickness values, i.e., Kakinuma. EX1003, ¶¶233, 240-46. As it relates to negative current collector thickness (called “negative electrode core material” in Kakinuma), Kakinuma teaches “[t]he thickness of the negative electrode core material is not particularly limited, but it is preferably 1 μm or more and 500 μm or less, more preferably 5 μm or more and 20 μm or less.” EX1010, ¶57. Following this instruction, “the strength of the negative electrode plate 2 can be maintained, while the negative electrode plate 2 can be made lighter.” *Id.* Thus, Kakinuma discloses a *current collector thickness of $S_1 = 20 \mu\text{m}$* . EX1003, ¶244.

This is between “4 μm to 30 μm ,” as recited in claims 2 and 11. EX1003, ¶¶263-68, 273-74.

With respect to the negative tab (lead) thickness, Kakinuma teaches “[t]he negative electrode lead 6 has the characteristic of bending with small pressure, and its shape is not particularly limited, which may be, for example, a rectangular shape with a welding allowance to the negative electrode core material and a welding allowance to the battery case 1...” EX1010, ¶53. Notably, Kakinuma teaches “the thickness of the negative electrode lead 6 is preferably 10 μm or more and 120 μm or less.” *Id.* Thus, Kakinuma teaches a ***negative tab thickness of $S_2 = 120 \mu\text{m}$*** . EX1003, ¶¶247-53.

Kakinuma also teaches a total electrode plate thickness of 150 μm . EX1010, ¶94. Thus, the active material can be determined by subtracting the current collector thickness from the total electrode thickness and dividing it by two (because active material is on both sides of the current collector). EX1003, ¶260. Selecting the value of 20 μm from the “most preferred” current collector thickness results in an active material thickness of 65 μm (because $150 - 20 / 2 = 65$). Selecting a negative lead (tab) thickness value of 120 μm from the “preferred” range disclosed by Kakinuma also results in a ***value of an active material thickness of $S_3 = 65 \mu\text{m}$*** . *Id.*, *Id.* at 254-62.

Reading passages in Kakinuma together, a POSA would appreciate the importance of the thicknesses of the three components for battery performance, particularly because Kakinuma is directed to the production of batteries of suitable thickness to “increase battery capacity.” EX1010, ¶¶3, 51-57. A POSA would realize that thickness of battery components, including tab, active material, and current collector are result-effective variables for battery weight and energy density. EX1003, ¶259. A POSA would have had reason to optimize the thickness of the negative current collector, negative tab, and negative active material from the teachings of Kakinuma, particularly within the “preferred” ranges provided by Kakinuma. *Id.* at ¶¶260, 270-72.

A POSA would have understood how and why to take these teachings of Kakinuma and combine them with Guo-Hu to meet this feature. Section IX.A.

2. [2.1.1]/[11.1.1]

Kakinuma teaches S_1 , S_2 , and S_3 values of 20 μm , 120 μm , and 65 μm , respectively. These values result in the recited relationship formula (II), i.e., $0.9 \times (S_1 + 2S_3) \leq S_1 + S_2 \leq 1.1 \times (S_1 + 2S_3)$, being met because $0.9 \times (20 + 2(65)) \leq 20 + 120 \leq 0.1 \times (20 + 2(65)) = 135 \leq 140 \leq 165$. EX1003, ¶¶229-230. Thus, a POSA following Kakinuma’s teachings would have generated a battery that met formula (II). EX1003, ¶¶226-230, 269.

A POSA would have understood how and why to take these teachings of Kakinuma and combine them with Guo-Hu to meet this feature. Section IX.A.

C. Guo-Hu-Kakinuma combination

A POSA would have had reason to incorporate the complete set of thickness parameters S_1 , S_2 , and S_3 as taught in Kakinuma, with a reasonable expectation of success, in the apparatus of Guo, modified in view of Hu. Additionally, merely changing the size of a component, such as the thicknesses of certain components, without any unexpected result does not give rise to a patentable invention. *Fox Factory, Inc. v. SRAM LLC*, 813 F. App'x 539, 542 (Fed. Cir. 2020) (“[A] mere change in proportion ... involve[s] no more than mechanical skill” (quoting *Powers-Kennedy Contracting Corp. v. Concrete Mixing & Conveying Co.*, 282 U.S. 175, 185 (1930))); *Iron Grip Barbell Co., Inc. v. USA Sports, Inc.*, 392 F.3d 1317, 1322 (Fed. Cir. 2004); *Gardner v. TEC Sys., Inc.*, 725 F.2d 1338, 1349 (Fed. Cir. 1984); EX1003, ¶¶153-55, 183.

Thus, each of claims 2 and 11 would have been obvious to a POSA in view of Guo, Hu, and Kakinuma.

XI. GROUND 1C: CLAIMS 5 AND 14 WOULD HAVE BEEN OBVIOUS OVER GUO, HU, AND WANG

A. MTC

Guo, Hu, and Wang are analogous art because all are directed to the construction of electrodes suitable for applications in cylindrical batteries. Wang

teaches an improvement to a wound battery cell configuration, and teaches its configuration improves energy density, reduces cost, and reduces the risk of cell deformation. EX1012, ¶20; EX1003, ¶¶275, 297.

Guo, Hu and Wang have many electrochemical apparatus components in common. Like Guo and Hu, the electrochemical apparatus (“wound cell,” EX1012, Title, ¶¶8, 48) of Wang comprises: a positive electrode (“second electrode plate,” *id.* at Abstract, ¶¶8, 48), a separator (“first separator” and “second separator,” *id.* at Abstract, ¶¶8, 48), and a negative electrode (“first electrode plate,” *id.* at Abstract, ¶8, 48), wherein the negative electrode comprises a negative current collector (“first current collector,” *id.* at ¶¶8, 49), a negative active material layer (“first active material layer,” *id.* at Abstract, ¶¶8, 49), and a negative tab (“first electrode tab,” *id.* at ¶¶8, 9, 49). EX1003, ¶276.

A POSA would have understood that the geometries of electrochemical apparatuses in the three references were compatible. A POSA would have recognized that the “wound-formed” geometry of Guo was functionally equivalent to Wang’s “wound cell.” EX1011, ¶¶8, 13, 74, 76; EX1012, Title, ¶¶8, 48; EX1003, ¶276. Hu is compatible with Wang for the same reasons Hu is compatible with Guo. EX1003, ¶277.

In addition, just as Guo and Hu disclose goals of improving energy density and safety (EX1011, ¶¶4, 79; EX1005, Abstract, ¶33), Wang discloses comparable

goals of producing devices that “improve energy density” and “reduce the risk of the cell deformation,” which a POSA would recognize as a safety improvement measure. EX1012, ¶¶20, 53, 54, 58. EX1003, ¶278.

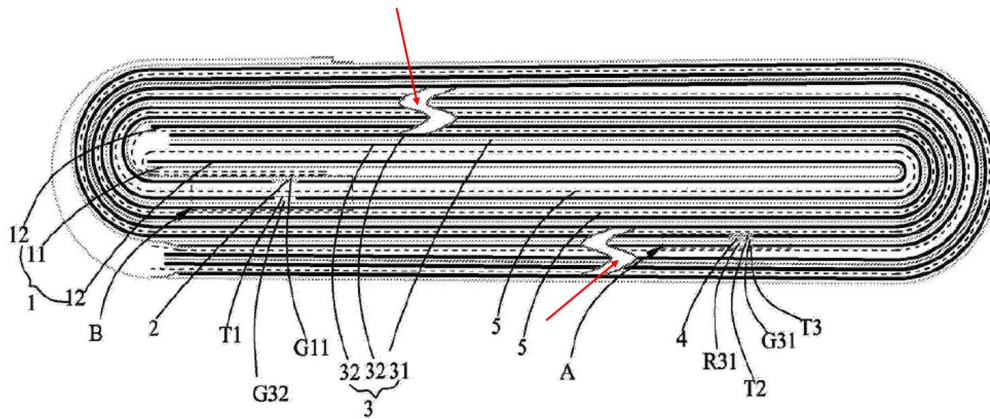
A POSA would have known to look to Wang to enhance Guo-Hu because the position of the negative tab relative to the center of the winding structure is not disclosed in Guo and Hu, and Guo states an express goal of improving “the energy density of the secondary battery” through “accommodating groove” features. EX1011, ¶7; EX1003, ¶292. In implementing Guo’s winding structure within a secondary battery, with the goal of improved energy density, a POSA would know to look to analogous art that expressly teaches a winding structure geometry that can further “improve energy density” through additional geometric modifications, as stated in Wang. EX1012, ¶20; EX1003, ¶¶279-81, 290-91.

A POSA would have been motivated to do so because Wang teaches “the wound cell of the present application can save usage amount of the separator, improve energy density, and reduce cost.” EX1012, ¶20. Wang further teaches “the electrode tab is arranged at the outer side of the cell, which increases the symmetry of the internal structure of the cell, and reduces the risk of cell deformation.” EX1012, ¶53. A POSA would have been motivated to position electrodes at least 3 layers away from the center of the wound battery to increase the symmetry of the cell, reducing risk of deformation, as taught in Wang. EX1003, ¶¶292-93.

B. Claims 5 and 14

The wound-formed secondary battery cell in Guo (e.g., Fig. 1) is an “electrochemical apparatus” “of a winding structure.” EX1011, ¶8, Fig. 1; EX1003, ¶282. The anode tab as described in Guo is a “negative tab.” EX1003, ¶¶282, 125.

Regarding the “negative tab ... arranged at a position beyond three layers from a center of the winding structure”, Guo teaches the following structure:

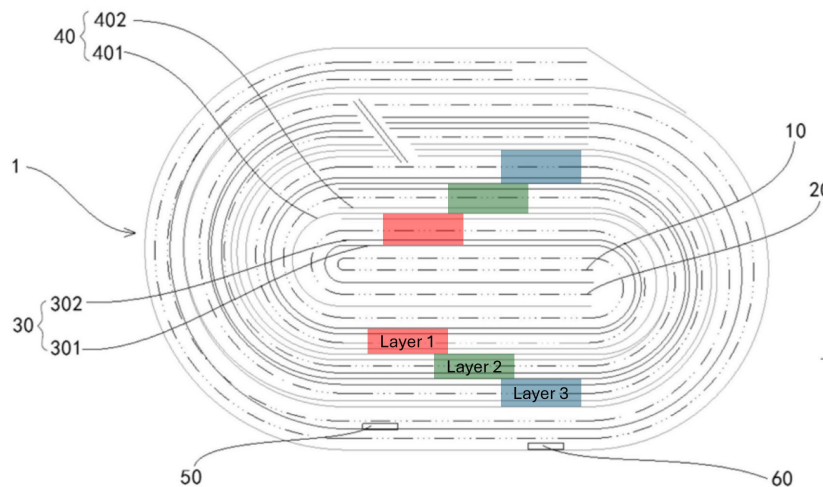


EX1011, FIG. 6 (annotated)

The negative tab position from the center of Guo’s winding structure (in terms of number of layers) is not explicitly disclosed in Guo. Fig. 6, but a POSA would understand that “breaks” in the structures (shown with red arrows in annotated Fig. 6) indicate that the total number of winds within each structure can be different from what is shown. EX1003, ¶¶283-85 (also discussing Guo Fig. 1; also citing EX1011, ¶¶83, 87).

The negative tab position arrangement relative to the center of a winding structure is also not expressed in Hu. EX1003, ¶286. A negative electrode meeting claims 5 and 14 was well known in the prior art, however, as taught by Wang. Because details of such arrangements were not presented in Guo or Hu, a POSA would have looked to Wang to determine the number of layers between the center of the structure and the negative tab. EX1003, ¶287.

Wang Fig. 4 is reproduced below:



EX1012, FIG. 4 (annotated)

Wang Fig. 4 shows negative tab 60 is positioned at least four layers from the center of the wound battery, i.e., beyond three layers from the center of the winding structure, as recited in claims 5 and 14. EX1003, ¶¶288-89.

C. Guo-Hu-Wang combination

A POSA would have been motivated to position electrodes at least 3 layers away from the center of the wound battery to increase the symmetry of the cell, reducing risk of deformation, as taught in Wang. EX1012, ¶¶20, 53, 54, 58; EX1003, ¶¶290-97. Thus, claims 5 and 14 are obvious over Guo, Hu, and Wang.

XII. GROUND 1D: CLAIM 7 WOULD HAVE BEEN OBVIOUS OVER GUO, HU, AND KUSAGAWA.

A. MTC

Guo, Hu, and Kusagawa are analogous art because all are directed to the construction of electrodes in similar cylindrical batteries. EX1003, ¶298. Guo, Hu and Kusagawa have many battery components in common. Like Guo and Hu, the electrochemical apparatus (“non-aqueous electrolyte secondary battery,” EX1008, Abstract, ¶¶1-4) of Kusagawa comprises: a positive electrode (“positive electrode plate,” *id.* at. Abstract, ¶¶16, 32), a separator (“separator,” *id.* at. Abstract, ¶¶16, 34), and a negative electrode (“negative electrode plate,” *id.* at. Abstract, ¶¶16, 27-28), wherein the negative electrode comprises a negative current collector (“negative electrode current collector,” *id.* at. Abstract, ¶¶16, 28), a negative active material layer (“negative electrode mixture layer,” *id.* at. Abstract, ¶¶16, 28), and a negative tab (“negative electrode tab,” *id.* at. Abstract, ¶¶16, 28). EX1003, ¶299.

Guo and Kusagawa also describe very similar battery geometries. Just as Guo discloses a “wound-type cell,” Kusagawa discloses “an electrode body formed

by winding,” and a negative electrode plate with a “winding start end” and a “winding finish end.” EX1011, ¶76; EX1008, Abstract, ¶16; EX1003, ¶300. In addition, just as Guo and Hu disclose goals of improving energy density and safety (EX1011, ¶¶4, 79; EX1005, Abstract, ¶33), Kusagawa discloses goals of producing batteries that have “higher capacity and output more power” and have “a high level of safety.” EX1008, ¶¶2-3; EX1003, ¶301.

A POSA would have known how to enhance Guo and Hu with the teaching of Kusagawa because Kusagawa spells out explicitly “production of negative electrode active material” and “production of negative electrode plate,” where the latter describes drying a slurry comprising the negative electrode active material “to both sides of a negative electrode current collector.” EX1003, ¶¶313-14, citing EX1008, ¶¶25-28. A POSA would have understood this method was compatible with the structure of Guo’s anode sheet, which similarly “comprises an anode current collector and an anode membrane disposed on the surface of the anode current collector.” EX1011, ¶5.

Kusagawa Example 15 describes the “production of silicon-graphite composite” containing a silicon-based material, and a material layer containing amorphous carbon on the surface of that silicon-based material. EX1008, ¶¶42-44; EX1003, ¶315. Example 15 states that “the amount of silicon in this composite was 20.9% by mass.” EX1008, ¶43. This composite in turn makes up 4% of the

negative active material, making the percentage of silicon-based material in the negative active material 0.836%. EX1008, ¶¶26, 44; EX1003, ¶310. A POSA would have understood how to enhance the teachings of Guo-Hu with Kusagawa's negative active material layer comprising a silicon-based material with 20.9% silicon by mass and a material layer (amorphous carbon) arranged on the surface of that silicon-based material. EX1003, ¶¶306-08, 313-16, 331-35, 341-45.

While Guo and Hu teach improved energy density, safety performance, and sheer stability, they do not specifically address the capacity of the negative active material. EX1003, ¶317. A POSA would have recognized the benefit of incorporating a weight percentage of silicon-based material of 0.836%, as taught in Kusagawa. This is because Kusagawa demonstrated that silicon-based active materials were known in the art to improve electrode capacity, and it provided multiple Examples detailing how to incorporate its teachings, including Example 15 having a negative active material layer with 0.836% silicon by mass. EX1008, ¶43; EX1003, ¶318. A POSA would have known to use Kusagawa's negative active material layer because Kusagawa disclosed why this type of active material layer improved capacity while overcoming known challenges regarding cycling characteristics. EX1008, ¶¶4, 5, 15, 17, 66-68; EX1003, ¶318.

In addition, POSA would have been motivated to add a material layer (amorphous carbon) on a surface of the silicon-based material because Kusagawa teaches that “[s]ince silicon materials have lower electron conductivity than graphite, the surface of the silicon material is preferably coated with carbon as described in Examples.” EX1008, ¶65; EX1003, ¶318. Indeed, each Example of Kusagawa, including Example 15, includes this additional carbon layer, i.e. the “material layer” recited in claim 7. EX1003, ¶319. A POSA would have understood that amorphous carbon, specifically, was a suitable choice of conductive coating (i.e., material layer) in this application, as known in the art. EX1003, ¶320 (citing EX1015, 11454-56; EX1016, Abstract, 21-26).

A POSA also would have recognized that Kusagawa’s disclosed negative active material layer, comprising a silicon-based material containing a material layer, would result in a successful combination with Guo-Hu because Kusagawa teaches that “any silicon material that contains Si and can reversibly intercalate and deintercalated lithium ions is expected to exert the advantageous effects of the present invention.” EX1008, ¶58; EX1003, ¶¶321-324.

B. Claim 7

Kusagawa Example 1 describes a “negative electrode mixture layer” formed from a dried “negative electrode mixture slurry,” wherein the negative electrode mixture slurry comprises a “negative electrode active material,” and the negative

electrode active material comprises “SiO coated with carbon.” EX1008, ¶¶27-28; EX1003, ¶309.

In Example 15, Kusagawa discloses a modification of Example 1 as follows:

Graphite particles and carbon pitch were added to the silicon-containing slurry and mixed to carbonize carbon pitch. The product was classified so as to obtain a particle size in a predetermined range, and carbon pitch was added to the obtained product. *The carbon pitch was carbonized to produce a silicon-graphite composite in which Si particles and graphite particles were bonded to each other with amorphous carbon.* The amount of silicon in this composite was 20.9% by mass.

A non-aqueous electrolyte secondary battery 10 in Example 15 was produced in the same manner as in Example 1 except that the silicon-graphite composite produced as described above was used instead of SiO coated with carbon.

EX1008, ¶¶43-44 (emphasis added). Kusagawa also discloses that “[s]ince silicon materials have lower electron conductivity than graphite, *the surface of the silicon material is preferably coated with carbon* as described in Examples.” EX1008, ¶65 (emphasis added); EX1003, ¶310. Indeed, Kusagawa describes this coating as “preferred,” teaching that “[i]n a silicon-graphite composite, silicon particles and graphite particles are preferably bonded to each other with amorphous carbon[.]” EX1008, ¶70.

Thus, in Example 15, Kusagawa discloses a negative electrode mixture layer formed from a dried negative electrode mixture slurry, wherein the negative electrode mixture slurry comprises a negative electrode active material, and the negative electrode active material comprises a silicon-graphite composite. EX1003, ¶310.

The negative electrode mixture layer in Kusagawa is a “negative active material layer” as recited in claims 1 and 7; the “Si particles” correspond to “silicon-based material” as claimed; and the amorphous carbon “bonded to” the Si particles is the claimed “material layer arranged on at least a part of a surface of the silicon-based material,” which “contains at least one of . . . amorphous carbon . . . ,” as recited in claim 7. EX1008, ¶¶43-44; EX1003, ¶¶310-12, 325-30, 336-40.

C. Guo-Hu-Kusagawa combination

A POSA would have recognized the benefit of incorporating Kusagawa’s silicon-based active material having a material layer (amorphous carbon) on at least a part of a surface of the silicon-based material into the Guo-Hu’s apparatus—and it would have been routine optimization to do so in view of the detailed teachings in Examples 1 and 15 in Kusagawa. EX1003, ¶¶302-05, 313-24, 331-35, 341-45. Thus, Guo, Hu, and Kusagawa render obvious claim 7.

XIII. GROUND 2A: CLAIMS 1, 3, 7, 9, 10, AND 12 WOULD HAVE BEEN OBVIOUS OVER TAO AND KUSAGAWA

A. MTC

Tao and Kusagawa are analogous art to the '686 patent and each other because both references are directed to the construction of electrodes suitable for applications in wound batteries with similar components. EX1007, ¶¶2, 8; EX1008, Abstract, ¶¶1-4; EX1003, ¶346. Both batteries comprise: a positive electrode, a separator, and a negative electrode, wherein the negative electrode comprises a negative current collector, a negative active material layer, and a negative tab. EX1007, ¶8, Fig. 4; EX1008, Abstract, ¶¶16, 27-28, 32, 34; EX1003, ¶¶75-80; 346-48; 350-63.

Tao discloses an electrochemical apparatus that includes nearly every element of claims 1 and 10, except it does not explicitly describe a negative electrode satisfying the “relationship formula (I) equation” because it does not describe a weight percentage of silicon-based material that satisfies formula (I), nor does it describe a silicon-based material weight percentage of “less than or equal to 70%” recited as “*G*” in claims 1 and 10. EX1003, ¶347. Nevertheless, these aspects of claims 1 and 10 were known in the art in view of Kusagawa, which disclosed a battery with a negative electrode having the recited weight percentage of silicon-based material. *Id.* A negative electrode satisfying the

formula (I) equation in claims 1 and 10 would have been obvious over Tao in view of Kusagawa.

Kusagawa teaches an improvement to a graphite-based negative active material layer like the one in Tao, mitigating the expansion and shrinkage of silicon by adding graphite to the active material layer. EX1008, ¶8; EX1003, ¶¶346-48. A POSA would have known to enhance the electrode composition of Tao with the silicon concentration taught in Kusagawa because Kusagawa expressly taught that its electrode compositions performed well, describing that “[s]ilicon materials, such as silicon and silicon oxide, having a higher capacity than carbon materials have recently attracted more attention as negative electrode active materials of non-aqueous electrolyte.” EX1008, ¶4; EX1003, ¶¶348, 359, 371-75. Kusagawa also warns “[h]owever, silicon materials undergo larger expansion and shrinkage with charging and discharging than carbon materials.” EX1008, ¶5; EX1003, ¶374. Kusagawa then explains how to balance silicon with carbon materials (like graphite) in a negative electrode active material to achieve “a high capacity and a good load characteristic.” EX1008, ¶¶15, 13-14; EX1003, ¶375.

Thus, a POSA would have been motivated to modify Tao by combining it with the teachings in Kusagawa because the POSA would have (1) identified a shortcoming in silicon active material layers like Tao’s, and (2) looked for a proposed solution to that shortcoming, such as taught in Kusagawa. A POSA

would have understood that both graphite and silicon have respective benefits and drawbacks, and that a careful balance between the two materials was beneficial.

EX1003, ¶¶371-75.

In this context, Kusagawa explains that its particular electrode composition of Si-graphite composite of 4% by mass (Example 15) performed favorably with respect to comparative examples that did not have any silicon material by mass. EX1008, ¶¶26, 59, Table 1; EX1003, ¶375. Thus, a POSA would have been motivated to use a mixture of graphite and silicon as active material components, as taught in Kusagawa, when constructing a negative electrode. EX1003, ¶375. A POSA would have understood that routine optimization of these components, as taught by Kusagawa, would have been advantageous for the development of a lithium-ion battery. *Id.*

A POSA also would have had a reasonable expectation of success doing so because Kusagawa teaches that “any silicon material that contains Si and can reversibly intercalate and deintercalate lithium ions is expected to exert the advantageous effects of the present invention.” EX1008, ¶58; EX1003, ¶376. And a POSA would have understood that Kusagawa’s 4% Si-graphite composite / 96% graphite compositions would have been compatible with the battery described in Tao, which has embodiments of both 95% graphite and 95% silicon. EX1008, Table 1; EX1007, Examples 1-2; EX1003, ¶376.

A POSA also would have understood that Tao's graphite active material could tolerate the incorporation of silicon because Tao discloses the use of silicon in other embodiments. EX1003, ¶377. Tao teaches an Example 2, which "is almost the same as Example 1, except that ... [t]he negative active material is silicon." *Id.*; EX1007, ¶¶41, 47. Thus, a POSA would have understood that silicon could have been readily incorporated into the graphite active material of Tao Example 1, and such an active material would perform favorably. EX1003, ¶¶376-78.

A. Independent Claims 1 and 10

1. [1.P]-[1.3]/[10.P]-[10.3]

Tao discloses a lithium-ion battery, which a POSA would have understood to be an "electronic apparatus" comprising "an electrochemical apparatus." EX1007, ¶¶2, 8; EX1003, ¶¶351, 379. Tao's battery includes a positive electrode ("a positive plate"), a separator, and a negative electrode ("a negative plate"). EX1007, ¶8; EX1003, ¶¶349-54, 379-83.

1. [1.4]/[10.4] and [1.5.1]/[10.5.1]

Tao's battery comprises "a negative plate, including a negative current collector, a negative film formed on the negative current collector and a negative lead coupled to the negative current collector..." EX1007, ¶8; EX1003, ¶355. A POSA would have understood the negative electrode of Tao comprised a negative

current collector and a negative active material (“a negative film.”) EX1003, ¶¶355-56, 384-85; EX1007, ¶8.

2. [1.5.2]/[10.5.2]

Tao teaches an embodiment where “Example 2 is almost the same as Example 1, except that ... [t]he negative active material is silicon.” EX1007, ¶¶41, 47, 56; Example 3; EX1003, ¶357-59. Thus, Tao’s teaching of silicon as the negative active material satisfies the “silicon-based material” limitation.

In addition, Kusagawa enhances Tao’s teachings by specifically identifying other silicon-based materials that overcome known shortcomings of silicon in a battery such as the one described in Tao.

Kusagawa teaches “silicon materials undergo larger expansion and shrinkage with charging and discharging than carbon materials.” EX1008, ¶5. Kusagawa then explains how to balance silicon with carbon materials (like graphite) in a negative electrode active material to achieve “a high capacity and a good load characteristic.” EX1008, ¶15.

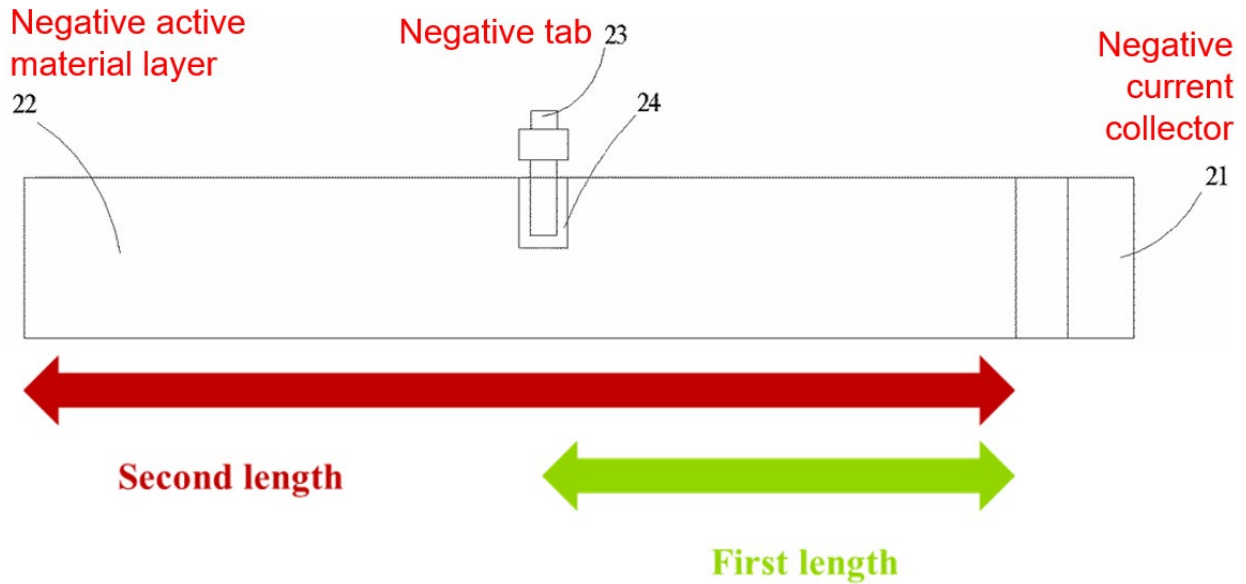
In pursuit of this goal, Kusagawa discloses that “[t]he negative electrode mixture layer contains a silicon material and graphite as negative electrode active materials.” EX1008, ¶16. An embodiment in Kusagawa is described as such: “(Production of Negative Electrode Active Material)” and “[b]y chemical vacuum deposition (CVD) where silicon oxide ... was coated with carbon. ... This SiO and

graphite were mixed such that the mass of SiO was 4% by mass relative to the total mass of SiO and graphite, whereby a negative electrode active material was produced.” EX1008, ¶¶25-26; EX1003, ¶359. And Kusagawa further teaches that in Example 15 that “a silicon-graphite composite in which Si particles and graphite particles were bonded to each other with amorphous carbon” was used in place of the SiO of Example 1. EX1008, ¶¶43-44. Thus, Kusagawa also discloses negative electrode active material, wherein the negative active material contains a silicon-based material (silicon dioxide). EX1003, ¶358, 386.

It would have been obvious how and why to combine these references to meet these claim features with an expectation of success in doing so.

3. [1.6.1]/[10.6.1]-[1.6.4]/[10.6.4]

Tao’s Fig. 4 discloses a “negative lead” (23), which a POSA would have known to be “negative tab” as recited in claim 1. EX1007, Fig. 4; EX1003, ¶¶360-64, 387.



EX1007/EX1022, FIG. 4 (annotated)

In Tao's Fig. 4, 21 is a negative current collector; 22 is the negative film (negative active material); 23 is the negative lead (negative tab); and 24 is a second recess. EX1007, ¶28, Fig. 4; EX1003, ¶362. As also shown in Figure 4, negative tab 23 is arranged on the side edge of the long axis of the current collector 21. EX1003, ¶¶361-62, 388.

The distances between a central position of the negative tab 23 and either end of the negative active material layer 22 in a long axis direction can be measured as a "first length." EX1003, ¶¶363-64, 389-90. Likewise, the length of a long axis of the negative active material layer 22 can be measured as "a second length." EX1003, ¶¶363-64, 389-90.

4. [1.7.1]/[10.7.1]-[1.7.3]/[10.7.3]

Tao teaches a value of $D=0.5$, and Kusagawa teaches a silicon-based material having a weight percentage (G) of 0.836%, which is less than or equal to 70%. EX1003, ¶¶365-70, 391-94. Combining these teachings results in the relationship recited in formula (I). *Id.*

Tao teaches that “[t]he distance between the center of the second recess 24 and one end of the negative film 22, i.e. one end of the negative film 12 perpendicular to a length direction of the negative current collector 21 and formed no blank negative current collector 21, is half of a length of the negative film 22.” EX1007, ¶31; EX1003, ¶¶367-68. Tao explains that “[a]ccording to one aspect of the present invention, ... a distance between a center of the second recess and one end of the negative film is half of a length of the negative film.” EX1007, ¶15; EX1003, ¶¶367-68. A POSA would have understood that the tab that is located in a recess at “half the length” of the negative film is located in the middle of the negative film. EX1007, ¶31; EX1003, ¶¶367-68. Thus, the “first length,” measured from the middle of the tab to the edge of the current collector, is half of the distance of the “second length.” Accordingly, Tao teaches $D=0.5$. EX1003, ¶¶367-68.

Kusagawa teaches a value of $G=0.836\%$ in Example 15. Specifically, Kusagawa teaches an Example 1 where “SiO and graphite were mixed such that

the mass of SiO was 4% by mass relative to the total mass of SiO and graphite, whereby a negative electrode active material was produced.” EX1008, ¶26; EX1003, ¶¶369-70. And Kusagawa Example 15 replaces this 4% SiO with 4% Si-graphite composite, which contains 20.9% Si by mass. EX1008, ¶¶43-44. Because Si is a silicon-based material, Kusagawa teaches a silicon-based material having $G=0.836\%$ (20.9% of 4%), which is less than or equal to 70%. EX1003, ¶¶369-70.

It would have been obvious to a POSA to incorporate the silicon-based material taught in Kusagawa into the negative active material layer of Tao. When Tao’s disclosed value of $D=0.5$ is combined with Kusagawa’s disclosed value of $G=0.836\%$ (0.00836), and both are inserted in formula (I) $0.5 \geq D \geq 0.6 \times G$, they yield: $0.5 \geq (0.5) \geq 0.6 \times (0.00836)$ or $0.5 \geq 0.5 \geq 0.005016$, which satisfies formula (I). EX1003, ¶¶365-70, 391-95.

5. Tao-Kusagawa Combination

POSA would have been motivated to enhance the battery of Tao with the silicon concentration taught in Kusagawa. EX1008, ¶4, 15; EX1003, ¶¶378, 395.

B. Claims 3 and 12

Tao in combination with Kusagawa teaches all elements of claims 1 and 10. Regarding dependent claims 3 and 12, Tao discloses an embodiment comprising a negative active material having a silicon-based material that is elementary silicon. EX1007, ¶¶8, 41, 47 (Example 2), 56 (Example 3). A POSA would have

understood that “silicon” is an elementary substance of silicon. EX1003, ¶¶396-407.

Tao also teaches negative active material that does not contain silicon. EX1007, ¶38 (Example 1). A POSA would have readily modified the battery in Tao to incorporate silicon, as taught by Kusagawa. EX1003, ¶¶396-407. When Tao is modified in view of Kusagawa, the silicon-based material comprises 0.836% Si particles. EX1008, ¶¶42-44 (Example 15). A POSA would have known Si particles are an elementary substance of silicon. EX1003, ¶¶396-407.

C. Claim 7

Although Tao may not expressly disclose a further “material layer” as recited in claim 7, such a layer was known in the art, as taught by Kusagawa.

Kusagawa teaches a second layer containing amorphous carbon arranged on the surface of the silicon-based material. Specifically, Kusagawa teaches that during “production of negative electrode active material,” “silicon oxide” was “coated with carbon” using a hydrocarbon gas that was “thermally decomposed” so that “the surface of SiO was coated with carbon.” EX1008, ¶¶26 (Example 1), 43 (Example 15) (teaching the use of amorphous carbon); EX1003, ¶¶408-10, 424-25. A POSA also would have known the layer of carbon in Kusagawa corresponded to a material layer as recited in claim 7. EX1003, ¶¶408-10, 424-25.

A POSA would have understood the benefit of this additional layer on top of the active material, because Kusagawa teaches that “[s]ince silicon materials have lower electron conductivity than graphite, the surface of the silicon material is preferably coated with carbon as described in Examples.” EX1008, ¶65. Indeed, each Example of Kusagawa includes this additional carbon layer. EX1003, ¶¶410-16. And Kusagawa teaches that “[i]n a silicon-graphite composite, silicon particles and graphite particles are preferably bonded to each other with amorphous carbon[.]” EX1008, [0070].

A POSA would further have been motivated to make this modification to Tao because Kusagawa praises its active material composition, describing that “[s]ilicon materials, such as silicon and silicon oxide, having a higher capacity than carbon materials have recently attracted more attention as negative electrode active materials of non-aqueous electrolyte.” EX1008, ¶4; EX1003, ¶¶415-23, 426-31.

D. Claim 9

Tao describes that “[a]ccording to one aspect of the present invention, the positive lead is entirely seated in the first recess and the *negative lead* [i.e., tab] *is entirely seated in the second recess*.” EX1007, ¶9 (emphasis added). A POSA would have understood that a “recess” is the same as a “groove” and that the negative lead is the same as a negative tab. EX1003, ¶¶432-36. Thus, Tao teaches the limitation recited in claim 9.

**XIV. GROUND 2B: CLAIMS 2 AND 11 WOULD HAVE BEEN OBVIOUS
OVER TAO, KUSAGAWA, AND KAKINUMA**

A. MTC

Tao, Kusagawa, and Kakinuma are analogous art because each of these references are directed to the construction of electrodes in wound batteries with non-aqueous electrodes. EX1010, ¶¶1, 9-18; EX1007, ¶¶2, 8; EX1008, Abstract, ¶¶1-4; EX1003, ¶¶437-38. All three batteries comprise: a positive electrode (“positive electrode plate,” EX1010, ¶¶51-52, 62-64), a separator (*id.*, ¶¶51, 73-75), and a negative electrode (“negative electrode plate,” *id.*, ¶¶51, 92-94), wherein the negative electrode comprises a negative current collector (“negative electrode core material,” *id.*, ¶¶53, 57, 94), a negative active material layer (“negative electrode mixture slurry,” *id.*, ¶¶93-94), and a negative tab (“negative electrode lead,” *id.*, ¶¶53, 98-99). EX1007, ¶8, Fig. 4; EX1008, Abstract, ¶¶16, 27-28, 32, 34; EX1003, ¶¶74-75, 352-56, 360.

Moreover, a POSA reading Kakinuma would have appreciated the importance of thicknesses of components, such as the negative current collector, negative tab, and negative active material, for battery performance, particularly because Kakinuma is directed to the production of batteries of suitable thickness. EX1010, ¶¶3, 52-57. A POSA would have realized that the thicknesses of battery components, including tab, active material, and current collector were result-

effective variables for battery weight and energy density. EX1003, ¶¶257-59, 458-59, 446-47.

Thus, a POSA would have been motivated to optimize the thicknesses of the negative current collector, negative tab, and negative active material in Tao's apparatus in view of teachings in Kakinuma, particularly within the ranges provided by Kakinuma. EX1003, ¶¶439-48. A POSA would have been motivated to engage in such routine optimization because Kakinuma teaches such battery component dimensions have superior properties, including strength, weight, and energy density. EX1010, ¶15 (referring to "both improved battery characteristics and enhanced long-term reliability and safety"), ¶51 (noting it "achieve[d] strong load characteristics"); ¶52 (stating its components "increase battery capacity"); EX1003, ¶¶414, 446, 447-48 (citing corroborating evidence EX1014, Abstract).

Merely changing the size of a component, such as the thicknesses of certain components, without any unexpected result does not give rise to a patentable invention. *Fox Factory*, 813 F. App'x at 542 (Fed. Cir. 2020) ("[A] mere change in proportion ... involve[s] no more than mechanical skill[.]"). Also, such a modification would only represent a modification in degree, rather than in kind, and would not have been unpredictable.

A. Claims 2 and 11

1. [2.1.2]/[11.1.2]- [2.1.4]/[11.1.4] and [2.2]/[11.2]

Tao and Kusagawa teach or disclose each element of independent claims 1 and 10. Kakinuma discloses a current collector thickness of $S_1 = 20 \mu\text{m}$, a negative tab thickness of $S_2 = 120 \mu\text{m}$, and an active material thickness of $S_3 = 65 \mu\text{m}$. Ground 1B; EX1010, ¶¶53, 57, 94; EX1003, ¶¶244, 251, 260, 440-41, 449-71. Kakinuma's current collector thickness of $S_1 = 20 \mu\text{m}$ is between "4 μm to 30 μm ," as recited in claims 2 and 11. Ground 1B; EX1003, ¶¶244, 263-268, 273-274.

2. [2.1.1]/[11.1.1]

Although Tao and Kusagawa may not expressly discuss the relationship presented in formula (II), a battery with relevant components satisfying that relationship was taught in the art, as described by Kakinuma. Kakinuma teaches S_1 , S_2 , and S_3 values of 20 μm , 120 μm , and 65 μm , respectively. Ground 1B. These values necessarily result in the recited relationship formula (II), i.e., $0.9 \times (S_1 + 2S_3) \leq S_1 + S_2 \leq 1.1 \times (S_1 + 2S_3)$, being met because $0.9 \times (20 + 2(65)) \leq 20 + 120 \leq 1.1 \times (20 + 2(65)) = 135 \leq 140 \leq 165$. Thus, a POSA following Kakinuma's teachings would have generated a battery that necessarily met formula (II). EX1003, ¶¶440-41, 466.

**XV. GROUND 2C: CLAIMS 4 AND 13 WOULD HAVE BEEN OBVIOUS
OVER TAO, KUSAGAWA, AND GUO**

A. MTC

Tao, Kusagawa, and Guo are analogous art because all are directed to the construction of electrodes suitable for applications in batteries with non-aqueous electrodes. EX1003, ¶480. The batteries in the references all comprise: a positive electrode, a separator, and a negative electrode, wherein the negative electrode comprises a negative current collector, a negative active material layer, and a negative tab. Although Tao and Kusagawa may not expressly teach “a ratio of the second length to a length of the long axis of the negative current collector is 0.8 to 1.0” (as recited in claims 4 and 13), that geometry was known in the art, as taught by Guo. EX1003, ¶472.

Guo cites a desire to “improve the energy density of the secondary battery.” EX1011, ¶¶7, 49. A POSA starting with the battery of Tao-Kusagawa would have had a similar goal, and it would have been routine optimization to take advantage of Guo’s teaching to reach that goal. A POSA would have been motivated to use the negative electrode of Guo in the battery of Tao-Kusagawa to maximize the coverage of the amount of negative active material per unit volume within the negative electrode, because this optimization reduced the total weight of nonactive materials in the lithium-ion batteries, which improved energy density, as known in the art. EX1003, ¶¶480-84, *citing* EX1021, Fig. 4, Fig 8.

Thus, a POSA would have had reason to set the length of a negative active material layer equal to that of the negative current collector, as shown in Fig. 3a in Guo, resulting in a ratio of 1.0. EX1011, Fig. 3a , EX1003, ¶¶472-84. In this vein, a POSA would have modified the length of the negative current collector in Tao-Kusagawa battery to match the length of the negative active material layer (i.e. the second length) along a long axis (i.e. the x-axis) as in Guo, Fig. 3a, which results in “a ratio of the second length to a length of the long axis of the negative current collector” of 1.0. EX1003, ¶¶480-83. A POSA also would have had a reasonable expectation of success doing so, in view of the specific teachings in Guo. *Id.* at ¶484.

A. Claims 4 and 13

“*D* is a ratio of the first length to the second length” in claim 1. Ground 1A. With respect to claims 4 and 13, Guo’s Fig. 3a teaches a relevant apparatus with the ratio recited in claims 4 and 13. Specifically, the length of the negative current collector (“D1”) matches the length of the upper negative active material layer (the claimed “second length”) along a long axis (i.e. the x-axis) in Fig. 3a in Guo, which results in “a ratio of the second length to a length of the long axis of the negative current collector” of 1. EX1011, Fig. 3a; EX1003, ¶¶474-79, 485. A POSA would have understood how and why to combine the references to meet these claims regarding a motivation to combine.

**XVI. GROUND 2D: CLAIMS 5 AND 14 WOULD HAVE BEEN OBVIOUS
OVER TAO, KUSAGAWA, AND WANG**

A. Claims 5 and 14

Wang explicitly discloses a relevant electrochemical apparatus that “is of a winding structure,” where “the negative tab is arranged at a position beyond three layers from a center of the winding structure.” EX1012, Fig. 4, ¶¶20, 53; EX1003, ¶¶486-90, 495.

B. MTC

Wang, Kusagawa, and Tao are analogous art because all three are directed to the construction of electrodes in wound batteries with non-aqueous electrodes. The batteries in the three references all comprise: a positive electrode, a separator, and a negative electrode, wherein the negative electrode comprises a negative current collector, a negative active material layer, and a negative tab. EX1012, Abstract, ¶¶8, 9, 48, 49, 76; EX1003, ¶491.

Although Tao and Kusagawa are silent as it relates to what is recited in claims 5 and 14, such elements were known in the art, as taught by Wang. Moreover, a POSA would have been motivated to incorporate this design element in Wang because Wang teaches that “the wound cell of the present application can save usage amount of the separator, improve energy density, as well as reduce cost.” EX1012, ¶20; EX1003, ¶¶492-94. Wang also teaches that “the electrode tab is arranged at the outer side of the cell, which increases the symmetry of the

internal structure of the cell, and reduces the risk of cell deformation.” EX1012,

¶53. Thus, a POSA would have been motivated to position electrodes at least 3 layers away from the center of the wound battery to increase the symmetry of the cell, reducing risk of deformation, as taught in Wang. EX1003, ¶¶492-93.

A POSA also would have had a reasonable expectation of success in creating a battery as taught by Tao, Kusagawa, and Wang, because Tao teaches a wound battery just like Wang. EX1003, ¶494. And Wang specifically praises its wound battery configuration, making it one of a finite set of options that would have been obvious to try when making a battery of the types taught in Tao and Kusagawa. EX1003, ¶493. *In re Cyclobenzaprine Hydrochloride Extended-Release Capsule Pat. Litig.*, 676 F.3d 1063 (Fed. Cir. 2012). A POSA would have understood that the wound battery of Tao-Kusagawa would have been compatible with Wang’s design choice because the disclosures are directed to the same type of wound, nonaqueous electrolyte batteries with graphite electrodes. EX1003, ¶494.

XVII.GROUND 3: CLAIMS 1, 7, AND 10 WOULD HAVE BEEN OBVIOUS IN VIEW OF GUO AND KUSAGAWA

Grounds 1A and 1D present a strong case of obviousness of claim 7 based on Guo, Hu, and Kusagawa. Ground 3 presents an alternative ground demonstrating how claim 7, claim 1 (upon which claim 7 depends) and claim 10, are also obvious over Guo and Kusagawa alone. EX1003, ¶¶496-97.

A. MTC

Guo and Kusagawa are analogous art to each other and the '686 patent. *Id.* Guo discloses nearly all limitations recited in claims 1 and 10 but does not disclose a silicon-based material as part of its negative active material—namely because Guo does not provide this level of detail—but Kusagawa does. Ground 1D; EX1003, ¶¶504-58, 568-83.

A POSA would have known how to enhance Guo with the teaching of Kusagawa because Kusagawa spells out explicitly the “production of negative electrode active material” and the “production of negative electrode plate,” where the latter describes drying a slurry comprising the negative electrode active material “to both sides of a negative electrode current collector.” EX1008, ¶¶25-28; EX1003, ¶¶559-65. A POSA would have understood that this method was compatible with the structure of Guo’s anode sheet, which “comprises an anode current collector and an anode membrane disposed on the surface of the anode current collector.” EX1011, ¶5; EX1003, ¶566.

Example 15 in Kusagawa teaches how to make a negative electrode active material comprising 0.836% Si by mass, where the Si is coated with amorphous carbon. EX1008, ¶¶25-26, 42-44. This Example describes the “production of silicon-graphite composite” containing a silicon-based material, and a material layer containing amorphous carbon on the surface of that silicon-based material.

EX1008, ¶¶42-44. In view of such teachings, a POSA would have understood how to enhance the teachings of Guo with Kusagawa's negative active material layer comprising a silicon-based material, such as with 0.836% Si by mass, which had a material layer carbon (such as amorphous carbon) arranged on its surface. EX1003, ¶¶560-66.

While Guo taught improved energy density, safety performance, and sheer stability, it is silent as to the performance of its apparatus with respect to active material capacity, specifically. A POSA would have recognized the benefit of incorporating a weight percentage of silicon-based material as taught in Kusagawa because Kusagawa demonstrated that silicon-based active materials were known in the art to improve electrode capacity, and it provided multiple Examples detailing how to incorporate its teachings. EX1008, ¶43. A POSA would have known to use Kusagawa's negative active material layer because Kusagawa disclosed why this type of active material layer improved capacity while overcoming known challenges regarding cycling characteristics. EX1008, ¶¶4, 5, 15, 17, 66-68. Kusagawa also praises its active material composition, describing that "[s]ilicon materials, such as silicon and silicon oxide, having a higher capacity than carbon materials have recently attracted more attention as negative electrode active materials of non-aqueous electrolyte." EX1008, ¶4.

In addition, a POSA would have been motivated to add a material layer (such as amorphous carbon) on at least a part of a surface of the silicon-based material because Kusagawa teaches that “[s]ince silicon materials have lower electron conductivity than graphite, the surface of the silicon material is preferably coated with carbon as described in Examples.” EX1008, ¶65. Indeed, each Example of Kusagawa, including Examples 1 and 15, includes this additional carbon layer, i.e. the “material layer” recited in claim 7. A POSA would have understood that amorphous carbon, specifically, is a suitable choice of conductive coating (i.e., material layer) in this application, as is known in the art. EX1003, ¶323 (citing EX1015, 11454-56; EX1016, Abstract, 21-26).

A POSA also would have recognized that Kusagawa’s disclosed negative active material layer, comprising a silicon-based material containing a material layer, would result in a successful combination with Guo because Kusagawa teaches that “any silicon material that contains Si and can reversibly intercalate and deintercalated lithium ions is expected to exert the advantageous effects of the present invention.” EX1008, ¶58; EX1003, ¶601.

A. Claims 1 and 10

Guo discloses nearly every limitation recited in claims 1 and 10 but does not disclose a silicon-based material as part of its negative active material (limitation [1.5.2]/[10.5.2]). Ground 1A; EX1003, ¶¶498-508, 523-33, 568-73, 575-78.

Similarly, while Guo discloses *D* (limitation [1.7.2]/[10.7.2]) recited in formula (I) in claims 1 and 10, it does not specifically disclose *G*, which relates to silicon-based material and its weight percentage and therefore a negative electrode satisfying the relationship formula (I) (limitations [1.7.1]/[10.7.1], [1.7.3]/[10.7.3], [1.7.4]/[10.7.4]). While Guo does not provide this level of detail, Kusagawa does.

1. [1.5.2]/[10.5.2]

Kusagawa teaches “silicon materials undergo larger expansion and shrinkage with charging and discharging than carbon materials.” EX1008, ¶5. Kusagawa then explains how to balance silicon with carbon materials (like graphite) in a negative electrode active material to achieve “a high capacity and a good load characteristic.” EX1008, ¶15. In pursuit of this goal, Kusagawa discloses an embodiment described as: “(Production of *Negative Electrode Active Material*)” “[b]y chemical vacuum deposition (CVD) where *silicon oxide ... was coated with carbon*. ... This SiO and graphite were mixed ... whereby a negative electrode active material was produced.” EX1008, ¶¶25-26 (emphasis added). Thus, Kusagawa discloses negative electrode active material, wherein the negative active material contains a silicon-based material and would have been obvious to combine with Guo. EX1003, ¶¶509-522, 574.

2. [1.7.1]/[10.7.1]-[1.7.4]/[10.7.4]

A POSA would have understood that Guo disclosed “ D ,” i.e., a ratio of the first length to the second length.” Ground 1A. As shown in Guo’s Fig. 3a and 3b, the “first length” disclosed by Guo is equal to $(D1)/2$, and considering the “second length” is equal to $D1$, the ratio (D) of the first length to the second length is equal to $((D1)/2)/(D1)$. Thus, D is equal to 0.5. EX1003, ¶¶534-67 (citing EX1011, ¶¶66, 74, Figs. 3a, 3b), 579-83.

Kusagawa teaches a “ G ” value of 0.00836. Specifically, in Example 15, Kusagawa teaches a weight percentage of 0.836% relative to the total mass of Si-graphite composite and graphite. EX1008, ¶26. Thus, Kusagawa discloses a G value that is less than or equal to 70%. EX1003, ¶¶534-66, 579-83.

The 0.836% value results in a $0.6G$ value of $0.6 \times 0.836\% = 0.5016\%$ (0.005016 when expressed as a fraction of 1). EX1003, ¶553. Substitution of $0.6G = 0.005016$ (as disclosed in Kusagawa) and $D = 0.5$ (as disclosed in Guo) into formula (I) yields $0.5 \geq 0.5 \geq 0.005016$, thus satisfying the conditions of formula (I). EX1003, ¶542. Thus, a negative electrode that satisfies $0.5 \geq D$ is taught by Guo, a negative electrode that satisfies $0.5 \geq 0.6 \times G$ is taught by Kusagawa, and a negative electrode that satisfies $0.5 \geq D \geq 0.6 \times G$ (formula (I)) is rendered obvious by Guo in view of Kusagawa. EX1003, ¶¶534-66, 579-83.

B. Claim 7

Kusagawa's Examples 1 and 15 disclose what is recited in claim 7. Ground 1D; EX1008, ¶¶27-28, 43-44, 65; EX1003, ¶¶310-11. Kusagawa's negative electrode mixture layer in Example 15, for instance, is a "negative active material layer" as recited in claims 1 and 10; the "Si particles" correspond to "silicon-based material"; and the amorphous carbon "bonded to" the Si particles is the claimed "material layer arranged on at least a part of a surface of the silicon-based material," which "contains at least one of . . . amorphous carbon," as recited in claim 7. EX1008, ¶¶43-44; EX1003, ¶¶584-88.

C. Guo-Kusagawa combination

A POSA would have recognized the benefit of incorporating Kusagawa's silicon-based active material having a material layer (amorphous carbon) on at least a part of a surface of the silicon-based material into the Guo's apparatus—and it would have been routine optimization to do so in view of detail teachings in Examples 1 and 15 in Kusagawa. EX1003, ¶¶589-622.

Thus, claims 1, 7, and 10 would have been obvious to a POSA in view of Guo and Kusagawa.

**XVIII. CERTIFICATION THAT THE PATENT MAY BE
CONTESTED VIA *INTER PARTES* REVIEW BY PETITIONER
AND STANDING (37 C.F.R. § 42.104(A))**

Petitioner certifies the '686 patent is available for IPR and Petitioner is not barred or estopped from requesting IPR of any '686 patent claim.

XIX. MANDATORY NOTICES (37 C.F.R. § 42.8(A)(1))

Real Party-in-Interest (37 C.F.R. § 42.8(b)(1)): The real parties-in-interest are Zhuhai CosMX Battery Co., Ltd.; Chongqing CosMX Battery Co., Ltd.; Zhuhai CosMX Power Jinwan Subsidiary Co., Ltd.; Zhuhai CosMX Power Battery Co., Ltd.; Zhuhai CosMX Power Supply Co., Ltd.; Zejiang CosMX Battery Co., Ltd.; Zejiang CosMX Power Supply Co., Ltd.; and Chongqing CosMX Battery Co., Ltd.

Related Matters (37 C.F.R. § 42.8(b)(2)):

The '769 patent was asserted in the litigation *Ningde Amperex Technology Limited v. Zhuhai CosMX Battery Co., Ltd.*, Case No. 2:26-cv-00139 (E.D. Tex.), filed February 18, 2026, dismissed June 16, 2026.

Petitioner is concurrently filing petitions for *inter partes* review of Patent Owner's U.S. Patent Nos. 10,916,769 (IPR2026-00398) and 12,294,082 (IPR2026-00401).

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Service Information (37 C.F.R. § 42.8(b)(4)): Please direct all correspondence regarding this Petition to counsel at the above addresses and to PTAB@sternekessler.com and COSMXPTAB@leehayes.com. Petitioner consents to service by email at the addresses above.

XX. PROCEDURAL STATEMENTS

This Petition is filed in accordance with 37 C.F.R. § 42.106(a). Concurrently filed herewith are a Power of Attorney and Exhibit List under 37 C.F.R. §§ 42.10(b) and 42.63(e), respectively. The required fee is paid through Deposit Acct.

No. 19-0036 (Customer ID No. 45324). The Office is authorized to charge any fee deficiency, or credit any overpayment, to Deposit Acct. No. 19-0036 (Customer ID No. 45324).

XXI. CONCLUSION

Petitioner respectfully requests institution of *inter partes* review of claims 1-5, 7, 9-14 because those claims are unpatentable under 35 U.S.C. § 103(a) in view of the prior art.

Respectfully submitted,

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XXII.APPENDIX A: CHALLENGED CLAIMS

A. Comparison of Independent Claims

Claim Element	Independent Claim 1	Claim Element	Independent Claim 9
[1.P]	An electrochemical apparatus, comprising:	[10.P]	An electronic apparatus, comprising an electrochemical apparatus, wherein the electrochemical apparatus comprises:
[1.1]	a positive electrode;	[10.1]	a positive electrode;
[1.2]	a separator; and	[10.2]	a separator; and
[1.3]	a negative electrode;	[10.3]	a negative electrode;
[1.4]	wherein the negative electrode comprises a negative current collector;	[10.4]	wherein the negative electrode comprises a negative current collector;
[1.5.1]	a negative active material layer,	[10.5.1]	a negative active material layer,
[1.5.2]	wherein the negative active material layer contains a silicon-based material; and	[10.5.2]	wherein the negative active material layer contains a silicon-based material; and
[1.6.1]	a negative tab,	[10.6.1]	a negative tab,
[1.6.2]	wherein the negative tab is arranged on a side edge of a long axis of the negative current collector,	[10.6.2]	wherein the negative tab is arranged on a side edge of a long axis of the negative current collector,
[1.6.3]	a distance between a central position of the negative tab and either end of the negative active material layer in a long axis direction is a first length,	[10.6.3]	a distance between a central position of the negative tab and either end of the negative active material layer in a long axis direction is a first length,
[1.6.4]	a length of a long axis of the negative active material layer is a second length, and	[10.6.4]	a length of a long axis of the negative active material layer is a second length, and
[1.7.1]	the negative electrode satisfies the following relationship formula (I): $0.5 \geq D \geq 0.6 \times G$ formula (I)	[10.7.1]	the negative electrode satisfies the following relationship formula (I): $0.5 \geq D \geq 0.6 \times G$ formula (I)

[1.7.2]	wherein D is a ratio of the first length to the second length,	[10.7.2]	wherein D is a ratio of the first length to the second length,
[1.7.3]	G is a weight percentage of the silicon-based material, and	[10.7.3]	G is a weight percentage of the silicon-based material, and
[1.7.4]	the weight percentage of the silicon-based material is less than or equal to 70%.	[10.7.4]	the weight percentage of the silicon-based material is less than or equal to 70%.

B. Groupings of Substantively Similar Dependent Claims

- 2/11
- 3/12
- 4/13
- 5/14

C. Listing of All Challenged Claims

1. **[1.P]** An electrochemical apparatus, comprising:
 - [1.1]** a positive electrode;
 - [1.2]** a separator; and
 - [1.3]** a negative electrode;
 - [1.4]** wherein the negative electrode comprises a negative current collector;
 - [1.5.1]** a negative active material layer,
 - [1.5.2]** wherein the negative active material layer contains a silicon-based material; and

[1.6.1] a negative tab,

[1.6.2] wherein the negative tab is arranged on a side edge of a long axis of the negative current collector,

[1.6.3] a distance between a central position of the negative tab and either end of the negative active material layer in a long axis direction is a first length,

[1.6.4] a length of a long axis of the negative active material layer is a second length, and

[1.7.1] the negative electrode satisfies the following relationship formula (I): $0.5 \geq D \geq 0.6 \times G$ formula (I)

[1.7.2] wherein D is a ratio of the first length to the second length,

[1.7.3] G is a weight percentage of the silicon-based material, and

[1.7.4] the weight percentage of the silicon-based material is less than or equal to 70%.

2. [2.1.1] The electrochemical apparatus according to claim 1, wherein the negative electrode satisfies the following relationship formula (II): $0.9 \times (S1 + 2(S3)) \leq S1 + S2 \leq 1.1 \times (S1 + 2(S3))$ formula (II)

[2.1.2] wherein S_1 is a thickness of the negative current collector,

[2.1.3] S_2 is a thickness of the negative tab,

[2.1.4] and S_3 is a thickness of the negative active material layer, and

[2.2] wherein the thickness S_1 of the negative current collector is 4 μm to 30 μm .

3. The electrochemical apparatus according to claim 1, wherein the silicon-based material contains at least one of an elementary substance of silicon, a compound of silicon, an alloy of silicon, or a silica material.

4. The electrochemical apparatus according to claim 1, wherein a ratio of the second length to a length of the long axis of the negative current collector is 0.8 to 1.0.

5. The electrochemical apparatus according to claim 1, wherein the electrochemical apparatus is of a winding structure, and the negative tab is arranged at a position beyond three layers from a center of the winding structure.

7. [7.1] The electrochemical apparatus according to claim 1,
wherein the silicon-based material further contains a material layer,
[7.2] the material layer is arranged on at least a part of a surface
of the silicon-based material, and
[7.3] the material layer contains at least one of a polymer, inorganic
particles, amorphous carbon or carbon nanotubes.
9. [9.1] The electrochemical apparatus according to claim 1, wherein the
negative electrode is provided with a groove, and
[9.2] the negative tab is arranged in the groove.

D. Comparison of Dependent Claims

Claim Element	Independent Claim 1 set		Independent Claim 9 set
[2.1.1]	The electrochemical apparatus according to claim 1, wherein the negative electrode satisfies the following relationship formula (II): $0.9 \times (S1 + 2(S3)) \leq S1 + S2 \leq 1.1 \times (S1 + 2(S3))$ formula (II)	[11.1.1]	The electronic apparatus according to claim 10, wherein the negative electrode satisfies the following relationship formula (II): $0.9 \times (S1 + 2(S3)) \leq S1 + S2 \leq 1.1 \times (S1 + 2(S3))$ formula (II)
[2.1.2]	wherein S1 is a thickness of the negative current collector,	[11.1.2]	wherein S1 is a thickness of the negative current collector,
[2.1.3]	S ₂ is a thickness of the negative tab,	[11.1.3]	S ₂ is a thickness of the negative tab,

Claim Element	Independent Claim 1 set		Independent Claim 9 set
[2.1.4]	and S ₃ is a thickness of the negative active material layer, and	[11.1.4]	and S ₃ is a thickness of the negative active material layer, and
[2.2]	wherein the thickness S ₁ of the negative current collector is 4 μm to 30 μm.	[11.2]	wherein the thickness S ₁ of the negative current collector is 4 μm to 30 μm.
[3]	The electrochemical apparatus according to claim 1, wherein the silicon-based material contains at least one of an elementary substance of silicon, a compound of silicon, an alloy of silicon, or a silica material.	[12]	The electronic apparatus according to claim 10, wherein the silicon-based material contains at least one of an elementary substance of silicon, a compound of silicon, an alloy of silicon, or a silica material.
[4]	The electrochemical apparatus according to claim 1, wherein a ratio of the second length to a length of the long axis of the negative current collector is 0.8 to 1.0.	[13]	The electronic apparatus according to claim 10, wherein a ratio of the second length to a length of the long axis of the negative current collector is 0.8 to 1.0.
[5]	The electrochemical apparatus according to claim 1, wherein the electrochemical apparatus is of a winding structure, and the negative tab is arranged at a position beyond three layers from a center of the winding structure.	[14]	The electronic apparatus according to claim 10, wherein the electrochemical apparatus is of a winding structure, and the negative tab is arranged at a position beyond three layers from a center of the winding structure.
[7.1]	The electrochemical apparatus according to claim 1, wherein the silicon-based material further contains a material layer,	N/A	
[7.2]	the material layer is arranged on at least a part of a surface	N/A	

Claim Element	Independent Claim 1 set		Independent Claim 9 set
	of the silicon-based material, and		
[7.3]	the material layer contains at least one of a polymer, inorganic particles, amorphous carbon or carbon nanotubes.	N/A	
[9.1]	The electrochemical apparatus according to claim 1, wherein the negative electrode is provided with a groove, and	N/A	
[9.2]	the negative tab is arranged in the groove.	N/A	

**CERTIFICATE OF COMPLIANCE WITH TYPE-VOLUME
LIMITATION, TYPEFACE REQUIREMENTS, AND TYPE STYLE
REQUIREMENTS (37 C.F.R. § 42.24(d))**

1. This Petition complies with the type-volume limitation of 14,000 words, comprising 13,946 words, excluding the parts exempted by 37 C.F.R. § 42.24(a).
2. This Petition complies with the general format requirements of 37 C.F.R. § 42.6(a) and has been prepared using Microsoft® Word in 14-point Times New Roman.

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CERTIFICATION OF SERVICE (37 C.F.R. §§ 42.6(e), 42.105(a))

The undersigned hereby certifies that on July 21, 2026, true and correct copies of the foregoing **PETITION FOR *INTER PARTES* REVIEW OF U.S. PATENT NO. 12,374,686** and all associated exhibits were served in their entirety on the following party via FedEx Express®:

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