

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Patent of: Seung Min Kim, et al.
U.S. Patent No.: 11,346,014 Attorney Docket No. 57533-0003IP1
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Appl. Serial No.: 16/643,758
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Title: ELECTROLYTIC COPPER FOIL, METHOD FOR PRODUCING
SAME, AND HIGH-CAPACITY LI SECONDARY BATTERY
NEGATIVE ELECTRODE INCLUDING SAME

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**PETITION FOR *INTER PARTES* REVIEW OF UNITED STATES PATENT
NO. 11,346,014 PURSUANT TO 35 U.S.C. §§ 311–319, 37 C.F.R. § 42**

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LIST OF EXHIBITS

SOLUS-1001	U.S. Patent No. 11,346,014 (“’014 Patent”)
SOLUS-1002	Excerpt of File History of the ’014 Patent
SOLUS-1003	Declaration of Dr. Jack Josefowicz
SOLUS-1004	U.S. Patent Application Publication No. 2010/0136434 (“Hanafusa”)
SOLUS-1005	U.S. Patent No. 8,715,836 (“Dobashi”)
SOLUS-1006	U.S. Patent No. 11,142,838 (“Lee”)
SOLUS-1007	U.S. Patent No. 9,209,485 (“Cheng”)
SOLUS-1008	U.S. Patent No. 8,349,518 (“Kim”)
SOLUS-1009	Song, Jenn-Ming et al., <i>Texture and temperature dependence on the mechanical characteristics of copper electrodeposits</i> , Materials Science & Engineering A 559, 655-664 (2013) (“Song”)
SOLUS-1010	Geometrical Product Specifications (GPS)—Surface texture: Profile method—Terms, definitions and surface texture parameters, JIS B 0601:(2001) (“JIS B 0601 (2001)”)
SOLUS-1011	Surface Texture (Surface Roughness, Waviness, and Lay), ASME B46.1-2009, August 20, 2010 (“ASME 2009”)
SOLUS-1012	U.S. Patent No. 4,981,560 (“Kajihara”)
SOLUS-1013	U.S. Patent Application Publication No. 2012/0205146 (“Oguro”)

SOLUS-1014	[RESERVED]
SOLUS-1015	[RESERVED]
SOLUS-1016	[RESERVED]
SOLUS-1017	<i>The ABC's of Arc Welding</i> , KOBELCO, available at https://www.kobelco-welding.jp/education-center/abc/ABC_2005-04.html , retrieved on August 22, 2024 (“KOBELCO”)
SOLUS-1018	[RESERVED]
SOLUS-1019	Barclay, William R. et al., <i>Electroplating—A Treatise on the Electro-Deposition of Metals with a Chapter on Metal-Colouring and Bronzing</i> , London-Edward-Arnold, 1912
SOLUS-1020	Kim, Jongsoo, et al., Effects of Organic Additives on Residual Stress and Surface Roughness of Electroplated Copper for Flexible PCB, <i>Corrosion Science and Technology</i> , Vol. 6, No. 4 (2007), pp.154-158
SOLUS-1021	ISO-6892-1, Metallic materials—Tensile testing—Part 1: Method of test at room temperature, International Standard, 2009
SOLUS-1022	IPC-TM-650, Test Methods Manual, Tensile Strength and Elongation, In-House Plating, No. 2.4.18.1, 05/04
SOLUS-1023	Zhu, Jianyu, et al., <i>Mechanical properties of commercial copper current collector foils</i> , The Royal Society of Chemistry, 2013
SOLUS-1024	<i>SK nexilis Co., Ltd. v. Solus Advanced Materials Co., Ltd. et al.</i> , Case 2-23-cv-00539 (EDTX), Proposed Scheduling Order
SOLUS-1025	<i>SK nexilis Co., Ltd. v. Solus Advanced Materials Co., Ltd. et al.</i> , Case 2-23-cv-00539 (EDTX), Motion to Transfer Venue

CLAIM LISTING

Limitation	Claim Language
[1pre]	An electrolytic copper foil having a first surface and a second surface, the electrolytic copper foil comprising:
[1a]	a first protective layer at the first surface;
[1b]	a second protective layer at the second surface; and
[1c]	a copper film disposed between the first and second protective layers, wherein
[1d]	wherein a binding coefficient of the electrolytic copper foil at the first surface or the second surface, defined as Mathematical Expression 1 below, is 1.5 to 9.4, (Mathematical Expression 1) Binding coefficient = $R_p/\mu\text{m} + \text{peak density}/30 + \text{amount of attachment of Cr}/(\text{mg}/\text{m}^2)$ (wherein the R_p (μm) is a peak height measured according to JIS B 0601 (2001) standard, wherein the peak density is a number of peaks per unit length of 4 mm, wherein the peak density is measured according to ASME B46.1 (2009) standard with a peak count level of $\pm 0.5 \mu\text{m}$ and wherein the amount of attachment of Cr (mg/m^2) is measured by dissolving the first surface or the second surface of the electrolytic copper foil (110) with a nitric acid solution to obtain a dissolved solution, diluting the dissolved solution with water to obtain a diluted solution, and analyzing the diluted solution using an atomic absorption spectrometer).

Limitation	Claim Language
[2]	The electrolytic copper foil according to claim 1, wherein an X-ray diffraction pattern of the copper film measured at the first surface or the second surface shows a texture coefficient of a (220) plane, defined by Mathematical Expression 2 below, of 0.49 to 1.28, 0.49 to 1.28, $TC(220) = \frac{\frac{I(220)}{I_0(220)}}{\frac{1}{n} \sum \frac{I(hkl)}{I_0(hkl)}} \quad (\text{Mathematical Expression 2})$ wherein TC(220) is the texture coefficient of the (220) plane, wherein I(hkl) is XRD diffraction strength of (hkl) crystal plane of the electrolytic copper foil, I₀(hkl) is XRD diffraction strength of (hkl) crystal plane of standard copper powder prescribed by Joint Committee on Power Diffraction Standards (JCPDS), wherein n is a number of diffraction peaks within 30° to 95° of diffraction angles (2 θ), and wherein the (hkl) crystal plane includes (111), (200), (220), and (311) crystal planes.
[3]	The electrolytic copper foil according to claim 1, wherein a weight deviation in lateral direction of the electrolytic copper foil is less than 3%.
[4]	The electrolytic copper foil according to claim 1, wherein the electrolytic copper foil has a yield strength of 21 to 49 kgf/mm ² measured at a normal temperature.
[5pre]	A method of manufacturing an electrolytic copper foil, the method comprising:
[5a]	electroplating a copper film on a rotary negative electrode drum by applying current between a positive electrode plate and the rotary negative electrode drum disposed in an electrolytic solution contained in an electrolytic bath so as to be spaced apart from each other;
[5b]	winding the electroplated copper film; and
[5c]	immersing the copper film in an anti-corrosion solution for anti-corrosion treatment,

Limitation	Claim Language
[5d]	wherein, when the electroplating is performed, a concentration of total carbon is maintained at 0.12 g/L or less and
[5e]	a concentration of Co^{2+} is maintained at 0.33 g/L or less.
[6]	The method according to claim 5, wherein a concentration of a nitrogen compound in the electrolytic solution is 3 to 12 ppm.
[7a]	The method according to claim 6, wherein the nitrogen compound comprises DETA, and
[7b]	a concentration of the DETA is 3.2 to 12 mg/L.
[8]	The electrolytic copper foil according to claim 1, further comprising: negative electrode active material layers on the first surface and the second.

I. INTRODUCTION

Solus Advanced Materials Co., Ltd. (“Solus” or “Petitioner”) petitions for IPR of claims 1-8 (“Challenged Claims”) of U.S. Patent No. 11,346,014 (“the ’014 Patent”). As explained in this petition, there exists a reasonable likelihood that Solus will prevail with respect to at least one of the Challenged Claims.

II. REQUIREMENTS FOR IPR

A. Grounds for Standing

Solus certifies that the ’014 Patent is available for IPR and that Petitioner is not barred or estopped from requesting this review challenging the Challenged Claims on the below-identified grounds.

B. Challenge and Relief Requested

The Challenged Claims are invalid based on the grounds noted in the table below, as further explained in this Petition. Accompanying explanations and support are provided in the Declaration of Dr. Jack Josefowicz. SOLUS-1003, [13]-[170].

Ground	Claims	Basis for Rejection - §103
1A	1, 4, 8	Hanafusa in view of Dobashi
1B	2	Hanafusa in view of Dobashi and Cheng
1C	3	Hanafusa in view of Dobashi and Kim
1D	5, 6	Hanafusa in view of Dobashi, and Lee
1E	7	Hanafusa in view of Dobashi and Kajihara

Each applied reference pre-dates foreign application KR10-2017-0111735,

filed on September 1, 2017 (“Critical Date”), which is the earliest filed application from which the ’014 Patent claims priority. Petitioner does not take a position as to whether the ’014 Patent is entitled to priority to the Critical Date, but has applied references that pre-date the Critical Date and qualify as prior art, as shown below.

Reference	Date	Section
Hanafusa	6/3/2010 (published)	102(a)(1)
Dobashi	2/19/2009 (published)	102(a)(1)
Cheng	12/8/2015 (published)	102(a)(1)
Kim	1/8/2013 (published)	102(a)(1)
Lee	3/28/2017 (filed)	102(a)(2)
Kajihara	1/1/1991 (published)	102(a)(1)

C. Level of Ordinary Skill in the Art

A person of ordinary skill in the art relating to the subject matter of the ’014 Patent as of the Critical Date (“POSITA”) would have had at least an undergraduate degree in materials science, chemical engineering, electrical engineering, or related field, or equivalent knowledge, training, or experience, with at least two years of experience working on the development of materials or components for electronic devices such as batteries. Additional education, such as a graduate degree, could compensate for less work experience, and additional work experience could compensate for less formal education.

D. Claim Construction

Petitioner submits that all claim terms should be construed according to the *Phillips* standard. *Phillips v. AWH Corp.*, 415 F.3d 1303 (Fed. Cir. 2005); 37 C.F.R. § 42.100. Based on the prior art’s description of the claimed elements being similar to that of the ’014 Patent specification, no formal claim constructions are necessary in this proceeding because “claim terms need only be construed to the extent necessary to resolve the controversy.” *Wellman, Inc. v. Eastman Chem. Co.*, 642 F.3d 1355, 1361 (Fed. Cir. 2011).¹

III. SUMMARY OF THE ’014 PATENT

A. Brief Description

The ’014 Patent describes its purported “invention” as an electrolytic copper foil manufactured through an entirely common, conventional, and standard electroplating method—using “a rotary negative electrode drum,” with a current applied between it and “a positive electrode plate” in an “electrolytic solution,” with optimized concentrations of certain additives including compounds of nitrogen, cobalt, and chromate, which are also entirely common, conventional, and

¹ Petitioner is not conceding that each claim satisfies all statutory requirements, such as §§ 101 and 112, nor is Petitioner waiving any arguments concerning claim scope or grounds that can only be raised in district court.

standard to the manufacture of electrolytic copper foils. SOLUS-1003, [17]-[18]; SOLUS-1001, cl. 5, 2:45-62, 7:25-8:38.

The '014 Patent further describes its purported “invention” as relating to an electrolytic copper foil with “high adhesiveness to a negative electrode material and a low electrical resistance” that “can be provided by controlling the surface properties of the electrolytic copper foil surface.” SOLUS-1001, Abstract. As the characteristics of the electrolytic copper foil, the '014 Patent introduces ranges for so-called “binding coefficient,” texture coefficient of a (220) plane, weight deviation, and yield strength. *Id.*, cls 1, 2, 3, 4, 2:25-45, 3:5-15, 4:53-5:22, 5:35-6:20. In particular, the claims recite that the binding coefficient at either surface of the electrolytic copper foil ranges from 1.5 to 9.4, that an “X-ray diffraction pattern of the copper film” at either surface of the foil measured at the first surface or the second surface shows a texture coefficient of a (220) plane, defined by Mathematical Expression 2 (shown below), is 0.49 to 1.28, and that the foil has a “yield strength of 21 to 49 kgf/mm².” *Id.*

Mathematical Expression 2:

$$TC(220) = \frac{\frac{I(220)}{I_0(220)}}{\frac{1}{n} \sum \frac{I(hkl)}{I_0(hkl)}}$$

SOLUS-1001, cl. 2, 5:35-66.

As will be shown below, each and every element set forth in the claims were well-known in the art. SOLUS-1003, [19], [22]-[35]. Importantly, while the claims recite specific ranges of values for these characteristics, the '014 Patent fails to demonstrate, or even suggest, that these ranges are critical to enhancing an electrolytic copper foil with “high adhesiveness to a negative electrode material and a low electrical resistance” that “can be provided by controlling the surface properties of the electrolytic copper foil surface.” SOLUS-1001, Abstract.

B. Prosecution History

The claims that issued in the '014 Patent were allowed after a single office action that only included indefiniteness rejections. SOLUS-1002, 374; SOLUS-1003, [20]-[21]. Particularly, the office action identified the claimed variables as not being defined by units or known variables. *Id.*

The claims were allowed with amendments that specify measurement units and/or standard of measurement. SOLUS-1002, 390-391. In the Notice of Allowance, the Examiner only identified a single prior art reference as not teaching the “binding coefficient” as expressed by claim 1. *Id.*, 479.

IV. THE CHALLENGED CLAIMS ARE UNPATENTABLE

A. [GROUND 1A]—Claims 1, 4, and 8 are Obvious Over Hanafusa-Dobashi

1. Overview of Hanafusa

Hanafusa describes electrolytic copper foil for lithium rechargeable batteries and a process for producing such foils. SOLUS-1004, [0007]; SOLUS-1003, [38]-[44]. This electrolytic copper foil has “good proof stress and elongation rate and will not be easily broken due to electrode breakage caused by charge and discharge of the lithium rechargeable battery[.]” *Id.*, Abstract.

Hanafusa manufactures its electrolytic copper foil by “subjecting the electrolytic copper foil to an annealing treatment at a specified temperature.” SOLUS-1004, [0008]. “Electrode breakage caused by repeated charge and discharge” may be prevented in such electrolytic copper foils when used in a negative current collector for a lithium rechargeable battery. *Id.*, [0008]. Such electrolytic copper foil would have “sufficient proof stress as an indicator of resistance to breakage and be flexible for expansion and contraction.” *Id.*, [0010].

Hanafusa’s electrolytic copper foil is “continuously manufactured” by “using a rotating metal cathode drum whose surface is polished, and an insoluble metal anode (positive electrode).” SOLUS-1004, [0016]. Copper is electrodeposited onto the cathode drum by “flowing copper electrolyte between the

cathode drum and the anode and applying an electrical potential between them.”

Id..

Hanafusa indicates that surface roughness Rz of the electrolytic copper foil impacts not only the prevention of breakage, but also the “adhesion to a negative-electrode material,” and provides a suitable range for Rz of the electrolytic copper foil. SOLUS-1004, [0029]. Specifically, Hanafusa states that to prevent breakage, “it is desirable that the surface roughness Rz of the electrolytic copper foil is 2.0 μm or less” and that when surface roughness Rz “is less than 1.0 μm , adhesion to a negative-electrode material tends to decrease.” *Id.* Hanafusa observes that although these are “optimum numerical conditions,” it “should be realized that **it is possible to manufacture an electrolytic copper foil that meets numerical conditions different**” from those disclosed, “**as the need arises.**” SOLUS-1004, [0030].²

Notably, Hanafusa discloses that in order to prevent cracks “it is necessary to make the rough surface low-profile; however, there is no particular limitation on how to make the rough surface low-profile. **In other words, all the known methods for making a rough surface low-profile can be used.**” SOLUS-1004, [0023].

² All emphasis is added unless indicated otherwise.

Hanafusa also indicates that chromium deposition, though useful to “prevent surface oxidation of the electrolytic copper foil,” may cause “degradation of the charge-discharge property of the lithium battery,” and therefore “it is necessary to keep the amount of chromium to the minimum.” SOLUS-1004, [0031]. Hanafusa provides a suitable range for chromium deposition of 2.6 to 4.0 mg/m². *Id.*, [0032]. Hanafusa observes that when “the risk of the surface oxidation is low or can be ignored,” “the rust-proof chromium layer may be used arbitrarily if required.” *Id.*, [0033].

2. Overview of Dobashi

Dobashi describes “a surface-treated electro-deposited copper foil” having desirable surface characteristics. SOLUS-1005, Abstract; SOLUS-1003, [45]. Among the surface parameters discussed is “RSm (JIS B 0601, 2001) obtained by using the stylus-type roughness meter.” SOLUS-1005, 6:24-25. Dobashi describes that RSm is “adopted as the period of waviness” and “used as an indicator for judgment of the surface. The surface has small waviness and is smooth when RSm is large, and the surface has large waviness and is rough when RSm is small.” *Id.*, 6:24-29. Dobashi describes the desirability of performing copper deposition in an electrolytic solution that “preferably comprises at least one selected from MPS [3-mercapto-1-propanesulfonic acid] and SPS [bis(3-sulfopropyl) disulfide],” and that

MPS and/or SPS can advantageously cause the matte side of the copper foil to be smooth. *Id.*, 11:60-12:13.

3. The Hanafusa-Dobashi combination

In the predictable combination, a POSITA would have recognized that Hanafusa's electrolytic copper foil would be implemented or modified to have the claimed peak density as taught by Dobashi. SOLUS-1003, [46]. In particular, the resulting electrolytic copper foil would have an Rz value between 1.0 to 2.0 μm (and therefore an Rp value less than the Rz values, as discussed in [1d] below) and a range for chromium deposition of 2.6 to 4.0 mg/m^2 (as discussed in [1d] below), as taught by Hanafusa, and further have the peak density ranging from 10.3 to 28.6, through Dobashi's disclosure of RSm values. *Id.*

Indeed, RSm is tightly linked to a peak density. SOLUS-1003, [47]. As Dr. Josefowicz explains, "a POSITA would have understood that RSm is essentially a measure of the average spacing between peaks, or, equivalently, a measure of the average width of 'profile elements.' A peak density (or, equivalently, Rpc or Pc), on the other hand, tells us how many peaks exist per unit length. That is, RSm and the peak density contain the same information and that the microscopic surface roughness characteristics can be derived from either RSm or Rpc." *Id.*

Using this recognition, and as described in more detail in Dr. Josefowicz's Declaration, a POSITA would have readily recognized that the RSm values

disclosed by Dobashi are converted into the peak density values that are compared directly to, and satisfy, those of the '014 Patent. SOLUS-1003, [48]. These converted values are utilized and noted with respect to [1d] below.

As noted by Dr. Josefowicz, both RSm and peak density would require the selection of “height discrimination” or “boundary lines” above/below which the surface profile must pass in order to count as a “peak.” SOLUS-1003, [49].

Although Dobashi does not explicitly disclose these discrimination lines, whereas the '014 Patent uses discrimination lines of $\pm 0.5 \mu\text{m}$ (SOLUS-1001, 14:20-23), Dr. Josefowicz notes that “the JIS B 0601 (2001) standard, according to which Dobashi’s RSm is calculated, teaches that, ‘if not otherwise specified, the default height discrimination shall be 10 % of [.] Rz.’” *Id.*; SOLUS-1010, 12. According to that standard, Rz (not to be confused with the ten-point roughness that often shares the same symbol) is the “maximum height of profile.” SOLUS-1010, 8. Dobashi discloses this parameter as PV, the “maximum peak to valley height.” SOLUS-1005, 7:55. As Dr. Josefowicz demonstrates, the disclosed PV is used to put upper limits on the peak density values corresponding to Dobashi’s RSm values, as explained in further detail in his Declaration. SOLUS-1003, [49].

Several reasons would have motivated a POSITA to implement or modify Hanafusa’s electrolytic copper foil to have the RSm value (and thus the peak density value) as disclosed by Dobashi. In particular, a POSITA would have been

motivated to apply Dobashi's disclosure of "RSm" to further achieve Hanafusa's stated purpose. SOLUS-1003, [50]-[51]. For example, Hanafusa describes that "it is necessary to make the rough surface low-profile; however, there is no particular limitation on how to make the rough surface low profile. In other words, all the known methods for making a rough surface low-profile can be used." SOLUS-1005, [0023]. Therefore a POSITA would have looked into other references like Dobashi to identify such a known method to make a rough surface low-profile. *Id.*; SOLUS-1003, [51]. Indeed, Dobashi teaches that "RSm can ... be used as an indicator for judgment of the surface. The surface has small waviness and is smooth when RSm is large." SOLUS-1005, 6:25-30.

A POSITA would have been further prompted to pursue this implementation of the RSm values (and thus peak density values) of Dobashi's electrolytic copper foil into Hanafusa's electrolytic copper foil as doing so is merely the application of known techniques (e.g., using additives such as MPS and SPS in electrolytic solution for the manufacture of electrolytic copper foil with desirable characteristics) to a known structure (e.g., electrolytic copper foil prepared through electrodeposition process) to yield predictable results (e.g., electrolytic copper foil with desirable characteristics including improved surface roughness properties). SOLUS-1003, [52]; *see KSR Int'l Co. v. Teleflex Inc.*, 550 U.S. 398, 417 (2007). A POSITA would have had a reasonable expectation of success in achieving the

Hanafusa-Dobashi combination, given that both Hanafusa and Dobashi describe manufacture of electrolytic copper foils with desirable surface roughness properties. SOLUS-1003, [52].

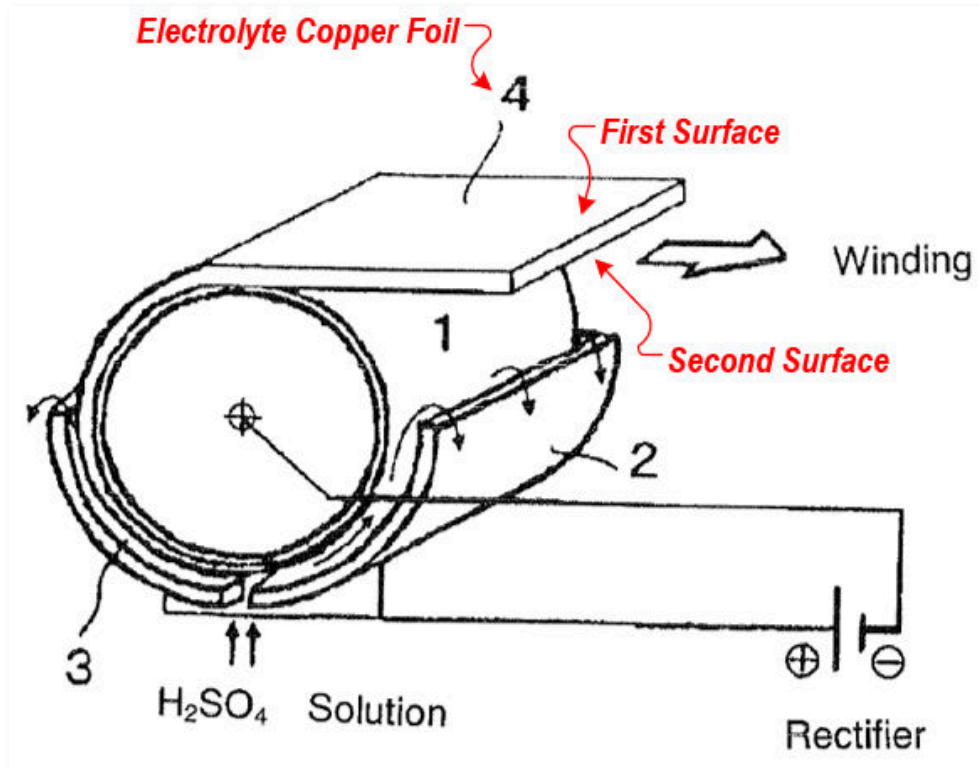
4. Analysis

(i) Claim 1

[1pre]:

To the extent the preamble is deemed to be limiting, Hanafusa discloses [1pre] or Hanafusa-Dobashi renders it obvious. SOLUS-1003, [53]. In particular, Hanafusa describes an “electrolytic copper foil for a lithium rechargeable (secondary) battery.” SOLUS-1004, Abstract. Similar to Hanafusa, Dobashi describes an electro-deposited copper foil. SOLUS-1005, Abstract.

The electrolytic copper foil in Hanafusa or Hanafusa-Dobashi has opposing surfaces corresponding to first and second surfaces, as illustrated in Hanafusa’s Figure 1 below. SOLUS-1004, [0018]; SOLUS-1003, [54].



Annotated Figure 1 of Hanafusa

[1a], [1b], [1c]:

Hanafusa or Hanafusa-Dobashi renders obvious [1a]-[1c]. SOLUS-1003, [55]-[56]. In particular, Hanafusa's electrolytic copper foil includes a "rust-proof chromium layer" (**protective layer**) on a surface of the electrolytic copper foil. SOLUS-1004, [0031], cls. 5, 12, 14, 15; SOLUS-1003, [56]. Hanafusa recognizes that the electrolytic copper foil needs to be surface-treated "to prevent surface oxidation of the electrolytic copper foil." SOLUS-1004, [0031]-[0034], [0004], [0013], [0024]. Hanafusa notes that "if the copper foil is left in the atmosphere for a long time, the copper foil will be oxidized and its charge-discharge property tends to degrade." *Id.*, [0032]. In context of this oxidation phenomenon, Hanafusa

specifies that “[t]herefore, the chromium deposition amount should preferably be 2.6 mg/m² or more to obtain the oxidation prevention effect by the rust-proof chromium layer.” *Id.* As such, a POSITA would have readily recognized that Hanafusa’s “rust-proof chromium layer” is a protective layer in that it is a surface treatment layer of the electrolytic copper foil to protect against undesirable phenomenon including oxidation. SOLUS-1003, [56].

To the extent that Hanafusa is not explicit as to its “rust-proof chromium layer” being applied to opposite sides of the electrolytic copper foil, a POSITA would have found it obvious to implement Hanafusa’s electrolytic copper foil having protective layers on both sides of the foil. SOLUS-1003, [57]. For example, Hanafusa recognizes the need for a “rust-proof chromium layer” (**protective layer**) to be applied “if the surface oxidation tends to easily occur when handling the electrolytic copper foil,” and thus a POSITA would have been motivated and found it obvious to apply such a rust-proof chromium layer to both surfaces (**first and second surfaces**) of the foil because the surface oxidation would naturally occur on both surfaces. SOLUS-1004, [0033]; SOLUS-1003, [57]. Indeed, Hanafusa notes that “it should be realized that the rust-proof chromium layer may be used **arbitrarily if required.**” SOLUS-1004, [0033]. A POSITA would have readily recognized that applying the protective layer to only one of the opposing sides of

the copper foil would not achieve the stated goal of Hanafusa (e.g., protect against oxidation). SOLUS-1003, [57].

[1d]:

Hanafusa-Dobashi renders obvious the claimed range of “binding coefficient.” SOLUS-1003, [58]. The ’014 patent defines the “binding coefficient” as the function of three independent variables: a peak height (“Rp”), a peak density, and an amount of Cr attachment at a surface of the electrolytic copper foil. SOLUS-1001, cl. 1. The ’014 patent further alleges, without evidence, disadvantages if the “binding coefficient” falls outside the claimed range (1.5-9.4). *Id.*, 5:23-33. As explained by Dr. Jack Josefowicz, however, the “binding coefficient” was unheard of and appears to be a value that the authors of the ’014 patent created. SOLUS-1003, [58]. Furthermore, the term “binding” implies that the variables in Mathematical Expression 1 have an effect on binding two surfaces and yet there is no description of a way to measure adhesion, nor does the ’014 patent show how the Mathematical Expression 1 was derived as it related to binding. *Id.* The ’014 patent is silent as to how the “binding coefficient” was developed or found, nor does it disclose any significance or advantage of using “binding coefficient” in determining the desired binding characteristic of the electrolytic copper foil, as opposed to looking at each of the three parameters that collectively define the value with no association to binding characteristic. *Id.*

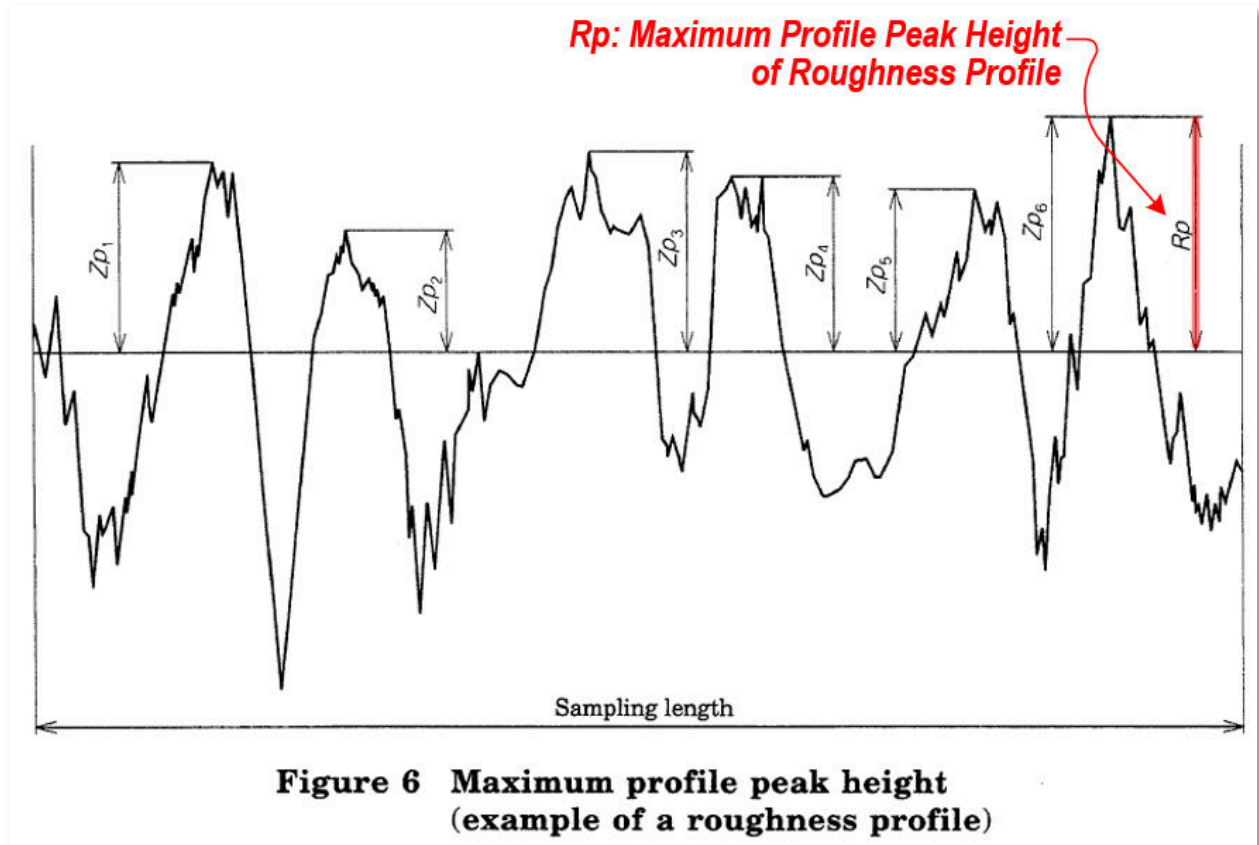
At a minimum, the claimed range of “binding coefficient” is broad and thus allows for a large range for each of the parameters: R_p , a peak density, and C_r attachment (or average thickness of C_r over the copper foil), which are clearly taught by Hanafusa-Dobashi. SOLUS-1003, [59].

Peak Height (“ R_p ”)

In the Hanafusa-Dobashi combination, the “ $R_p/\mu\text{m}$ ” value in the “binding coefficient” would be determined to be smaller than the range from $1.0\ \mu\text{m}$ to $2.0\ \mu\text{m}$ that is taught by Hanafusa’s surface roughness (R_z) value. SOLUS-1003, [60].

In particular, Hanafusa’s “copper foil for a lithium rechargeable battery” has “the surface roughness R_z of the copper foil is 1.0 to $2.0\ \mu\text{m}$.” SOLUS-1004, [0012]. A POSITA would have understood and found it obvious that Hanafusa’s “surface roughness R_z ” relates to, but is greater than, the “ $R_p/\mu\text{m}$ ”—“a peak height measured according to JIS B 0601 (2001) standard,” as required in claim 1. SOLUS-1003, [61]. Thus a POSITA would have understood and found it obvious that a value “ $R_p/\mu\text{m}$,” if measured for Hanafusa’s copper foil, must be less than Hanafusa’s disclosed maximum R_z value of $2.0\ \mu\text{m}$.

According to JIS B 0601 (2001) standard (as used in the ’014 patent), the peak height (R_p) is defined as the “maximum profile peak height of roughness profile,” illustrated as in Figure 6 (below). SOLUS-1010, 8-9; SOLUS-1003, [62].



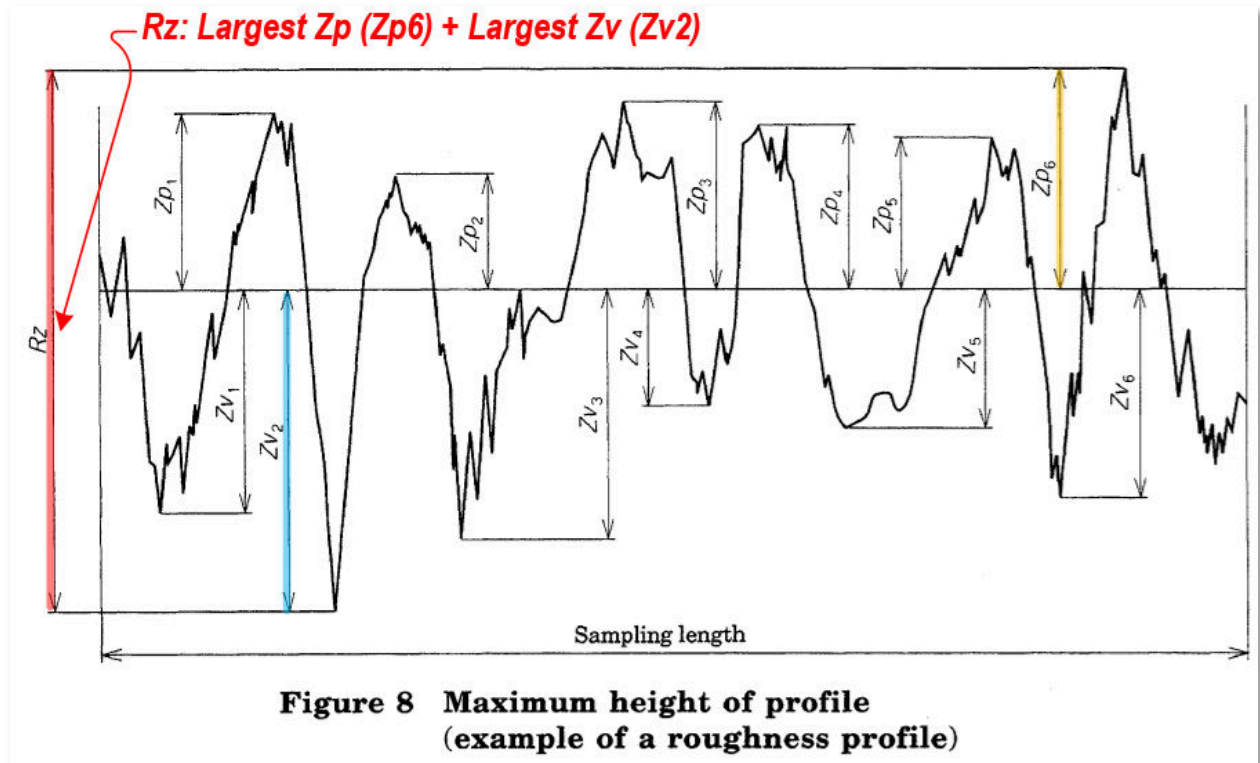
Annotated Figure 6 of SOLUS-1010

In the meantime, Hanafusa offers no definition of the surface roughness (R_z) while describing its particular range. SOLUS-1003, [63]. As explained by Dr. Jack Josefowicz, however, a POSITA would have understood that Hanafusa's surface roughness (R_z) would be defined according to known standards, and that JIS B 0601 (2001) (as used in the '014 patent) and ASME 2009 were two commonly-used standards for surface roughness measurements around the time of Hanafusa. *Id.*

According to JIS B 0601 (2001) standard, the surface roughness (R_z) is defined as the "sum of height of the largest profile peak height Z_p and the largest

profile valley depth Z_v within a sampling length (see Figure 8).” SOLUS-1010, 8.

Therefore, in the example of Figure 8, R_z is the sum of the largest profile peak height (Z_{p6}) and the largest profile peak valley (Z_{v2}). SOLUS-1003, [64].

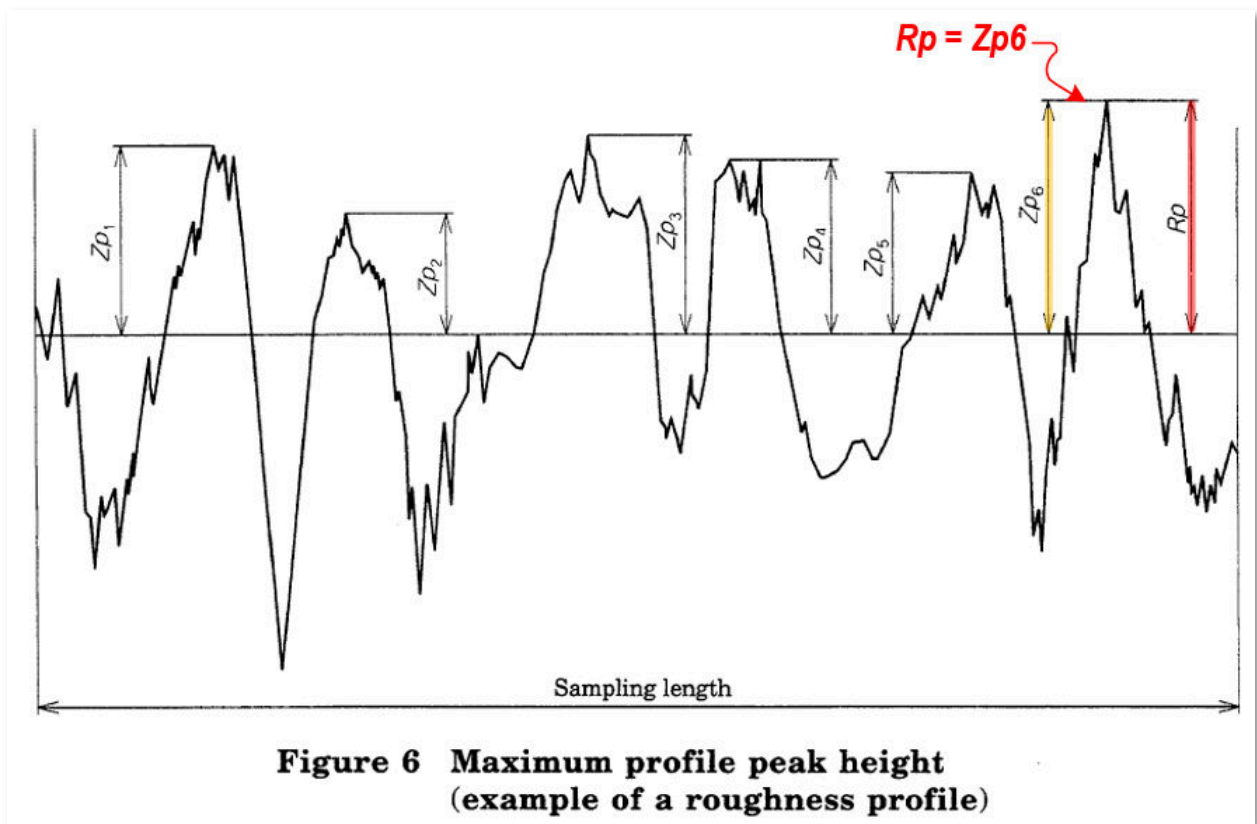


Annotated Figure 8 of SOLUS-1010

Therefore, a POSITA would have readily understood that, according to JIS B 0601 (2001) standard, the peak height (R_p), which is the “maximum profile peak height of roughness profile,” is always smaller than the roughness (R_z). SOLUS-1010, 8-9; SOLUS-1003, [65].

Referring to Figure 6 below as an example, R_p is the largest profile peak height within the sampling length, which is Z_{p6} . SOLUS-1010, 9; SOLUS-1003,

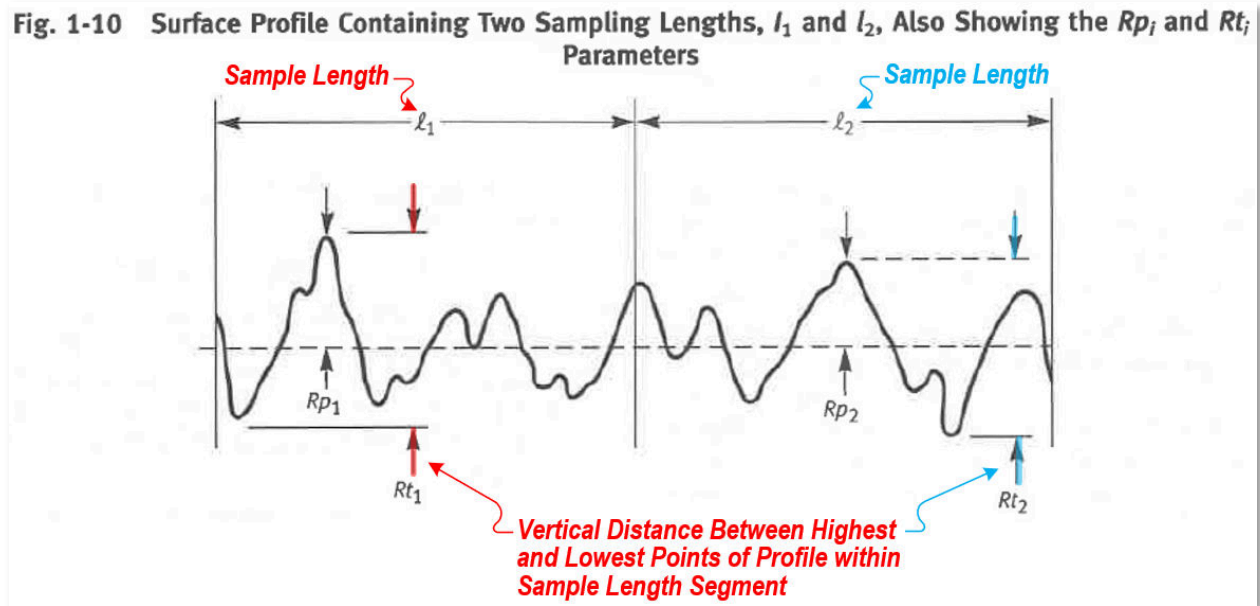
[66]. Again, under JIS B 0601 (2001) standard, $R_z = Z_{p6} + Z_{v2}$ while $R_p = Z_{p6}$, as illustrated in Figure 8 above. SOLUS-1010, 10; SOLUS-1003, [66]. Therefore, by definition, R_p values are always smaller than R_z values taken from the same electrolytic copper foil. SOLUS-1003, [66]. As a result, under JIS B 0601 (2001), it would have been obvious that Hanafusa's copper foil would have R_p that is smaller than R_z ranging from 1.0 to 2.0 μm under JIS B 0601 (2001). *Id.*



Annotated Figure 6 of SOLUS-1010

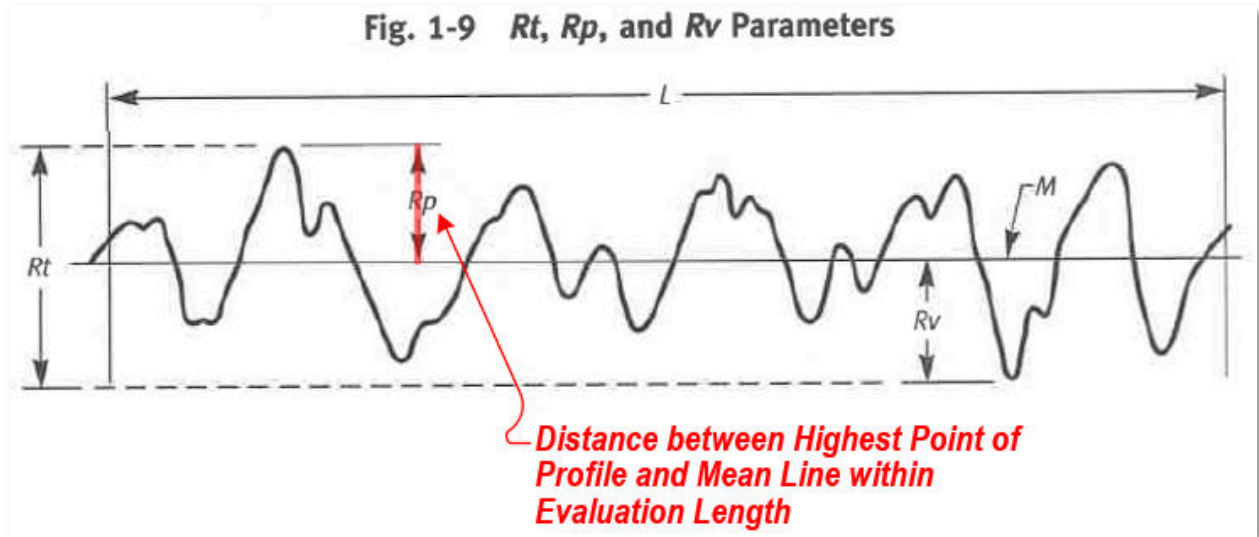
Another standard, ASME 2009, provides the same outcome. SOLUS-1003, [67]. According to ASME 2009, R_z is defined as “the average of the successive values of R_{t_i} calculated over the evaluation length.” SOLUS-1011, 8. R_{t_i} is defined

as “the vertical distance between the highest and lowest points of the profile within a sampling length segment labeled i (see Fig. 1-10).” SOLUS-1011, 8, Fig. 1-10 (below).



Annotated Figure 1-10 of SOLUS-1011

Further, ASME 2009 defines Rp as “the distance between the highest point of the profile and the mean line within the evaluation length (see Fig. 1-9).” SOLUS-1011, 8; SOLUS-1003, [68]. This is illustrated in Fig. 1-9 (below).



Annotated Fig. 1-9 of SOLUS-1011

As such, ASME 2009 defines R_p as the highest peak while R_z is defined as the sum of the highest peak and lowest valley. SOLUS-1011, 8; SOLUS-1003, [69]. This is the same as JIS B 0601 (2001) and thus, by definition, R_p values are always smaller than R_z values taken from the same electrolytic copper foil. SOLUS-1003, [69].

Accordingly, even under ASME 2009, a POSITA would have found it obvious that Hanafusa's copper foil would have R_p that is smaller than the disclosed R_z values ranging from 1.0 to 2.0 μm . SOLUS-1003, [70].

Peak Density

The Hanafusa-Dobashi foil would have a peak density, which contributes to the claimed binding coefficient, through the R_{Sm} values disclosed by Dobashi.

SOLUS-1003, [71]. In particular, the foil in Hanafusa-Dobashi would have a peak density of 10.3 to 28.6.

First, as noted above in Section IV.A.3 (Hanafusa-Dobashi combination) and as explained in more detail in Dr. Josefowicz's Declaration, a POSITA would have performed a straightforward calculation to convert Dobashi's matte side (deposit side) RSm into a matte side peak density. SOLUS-1003, [72]. RSm, as disclosed in Dobashi under JIS B 0601 (2001) standard, is defined as the "mean value of the profile element widths X_s within a sampling length" and is mathematically defined as:

$$RSm = \frac{1}{m} \sum_{i=1}^m X_{si}$$

SOLUS-1010, 12, Figure 10 (below).

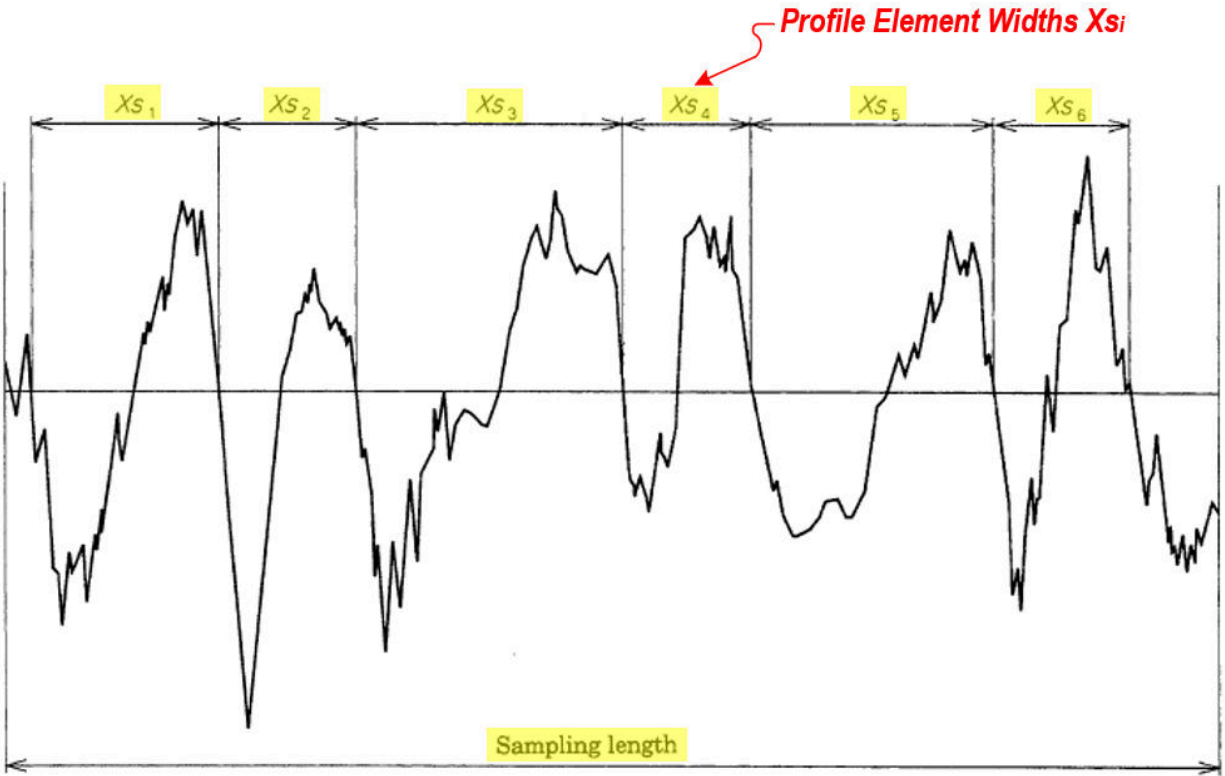


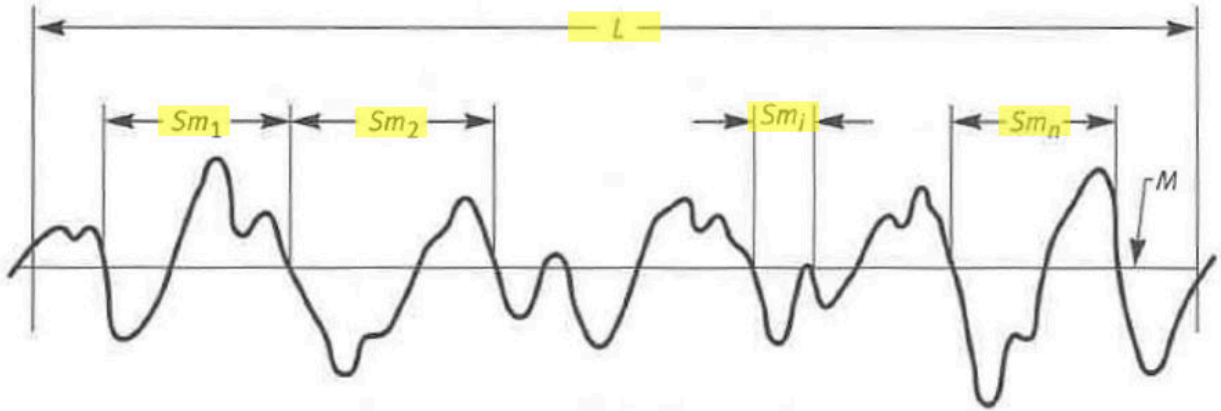
Figure 10 Width of profile elements

Annotated Figure 10 of SOLUS-1010

Here, RSm under the ASME B46.1 (2009) standard, which governs claim 1 peak density and therefore governs closely related RSm, is defined identically to JIS 0601 (2001) standard as “the mean value of the spacing between profile irregularities within the evaluation length” and is mathematically defined as:

$$RSm = \frac{1}{n} \sum_{i=1}^n S_{mi}$$

SOLUS-1011, 9, Fig. 1-13 (below); SOLUS-1003, [73].



Annotated Fig. 1-13 SOLUS-1011

Thus, a POSITA would have understood RS_m , according to either JIS 0601, 2001 or ASME B46.1, as the average lateral distance or spacing between individual peaks in a given sampling length. SOLUS-1003, [74].

Given an RS_m value (e.g., the average lateral distance or spacing between individual peaks) and a sampling/evaluation length (e.g., a unit length of 4 mm, as given in claim 1), a POSITA would have calculated a peak density of an electrolytic copper foil by dividing the sampling/evaluation length by the spacing between peaks. SOLUS-1003, [75]. This aligns with the '014 patent's disclosure that defines a peak density as "a number of peaks per unit length of 4 mm, wherein the peak density is measured according to ASME B46.1 (2009) standard with a peak count level of $\pm 0.5 \mu\text{m}[\cdot]$ " SOLUS-1001, cl. 1. Simply put, the number of peaks in a given sampling/evaluation length of copper foil would be calculated by dividing that sampling/evaluation length by the length, on average, between each of the peaks, or the spacing between peaks. SOLUS-1003, [75].

As such, as explained by Dr. Jack Josefowicz, a peak density is calculated

based on RSm as follows:

$$\begin{aligned} \text{Peak density} &= \text{Unit Length (sampling/evaluation length)} \\ &\div \text{RSm (spacing between peaks)} \\ &= 4 \text{ mm} / \text{RSm} \end{aligned}$$

By way of example, where the RSm value of Dobashi TABLE 2, Example 1 (below) is used, the peak density is calculated as follows:

$$\text{Peak density} = 4 \text{ mm} / 0.19 \text{ mm} = 21.1 \text{ peaks per 4 mm}$$

SOLUS-1003, [76]-[77]. Similarly, other resulting peak density values are shown in the modified Dobashi Table 2 below. Notably, the resulting peak density values range from 10.3 to 28.6. *Id.*, [78].

TABLE 2

Subject	Copper foil thickness (μm)	Deposit side of electro-deposited copper foil							Deposit Side Peak Density	Default Discrimination Criteria (μm)	
		Three-dimensional surface structure analysis			Stylus-type roughness meter		Gloss Gs				
		Wmax	PV	Wmax/PV	Rzjis	RSm	(60°)				
		(μm)	(μm)	(-)	(μm)	(mm)	TD	MD			
Example 1	15	0.37	0.39	0.949	0.32	0.19	659	665	→	21.1	0.039
Example 2	12	0.45	0.48	0.938	0.31	0.16	664	671	→	25	0.048
Example 3	70	0.065	0.079	0.823	0.17	0.39	691	686	→	10.3	0.0079
Example 4	15	0.27	0.30	0.904	0.29	0.18	790	790	→	22.2	0.03
Example 5	15	0.36	0.39	0.943	0.31	0.16	775	773	→	25	0.039
Example 6	12	0.42	0.44	0.959	0.47	0.22	654	687	→	18.2	0.044
Example 7	12	0.58	0.66	0.869	0.71	0.14	608	640	→	28.6	0.066
Comparative Example	12	0.82	1.87	0.439	1.00	0.07	324	383			

Modified Table 2 of Dobashi

Notably, Dobashi does not explicitly disclose discrimination lines to be used in RSm, peak density calculations, while the '014 Patent describes using $\pm 0.5 \mu\text{m}$. SOLUS-1003, [79]; SOLUS-1001, 14:20-23. However, as discussed in Section IV.A.3 (Hanafusa-Dobashi combination), the JIS 0601 (2001) standard describes how to determine “default” discrimination criteria using the equivalent of Dobashi’s PV. SOLUS-1003, [79]; SOLUS-1010, 10, 14. Dr. Josefowicz discusses that “the calculated default discrimination criteria using Dobashi PV values are much lower than the $\pm 0.5 \mu\text{m}$ used in the '014 Patent. Assuming that the disclosed RSm were measured according to the cited standard (which would be the most obvious conclusion), a POSITA would have understood that the use of the cited standard (resulting in more stringent requirements for what may be counted as a peak) would result in fewer peaks being measured, i.e., a **lower** Peak Density. As

such, a POSITA would have treated the calculated matte side Peak Density as upper bounds on the matte side Peak Density obtained using the cited standard $\pm 0.5 \mu\text{m}$ discrimination lines.” SOLUS-1003, [79].

Although Dobashi effectively discloses matte side peak density, Dobashi does not explicitly discuss the shiny side peak density. SOLUS-1003, [80]. However, even assuming the shiny side peak density has a much higher peak density than that of the matte side such that the shiny side the of the Hanafusa-Dobashi electrolytic copper foil could not plausibly meet the claimed “binding coefficient” limitation range of 1.5 to 9.4, this does not preclude Hanafusa-Dobashi from meeting the limitation. This is because the “binding coefficient” limitation need only be satisfied “at the first surface **or** the second surface,” and not both surfaces. SOLUS-1001, cl. 1. The matte-side peak density of the Hanafusa-Dobashi electrolytic copper foil, limited by Dobashi to a peak density of 28.6 or less, would clearly allow the binding coefficient limitation to be met, or at least would not preclude the limitation from being met.

Amount of Cr Attachment

Hanafusa-Dobashi would have the amount of attachment of Cr (mg/m^2) that is limited to a ceiling of 2.6 to $4.0 \text{ mg}/\text{m}^2$ with no floor. SOLUS-1003, [81]. Hanafusa discloses that an amount of deposition of chromium is adjusted to prevent surface oxidation of the electrolytic copper foil without causing

degradation of the charge-discharge property of the lithium battery. SOLUS-1004, [0013]. Hanafusa discloses that “a rust-proof chromium layer is provided on a surface of the electrolytic copper foil” but warns that “an excessive deposition. . . may degrade the charge-discharge property of the lithium battery. Therefore, an optimum deposition. . . of chromium is 2.6 to 4.0 mg/m².” SOLUS-1004, [0013]. Hanafusa further describes that “[t]herefore, it is necessary to keep the amount of chromium to the minimum” and that “if the risk of the surface oxidation is low or can be ignored, it is not particularly indispensable” and that “the rust-proof chromium layer may be used arbitrarily if required.” *Id.*, [0031]-[0033]. Hanafusa-Dobashi thus limits the amount of attachment of Cr (mg/m²) to a ceiling of 2.6 to 4.0 mg/m² and does not disclose its minimum in case the risk of surface oxidation is low or can be ignored. SOLUS-1003, [81].

Binding Coefficient

In the Hanafusa-Dobashi combination, the electrolytic copper foil would have the binding coefficient that falls within the claimed range (1.5 to 9.4) based on the peak height, the peak density, and the amount of Cr attachment, as provided by the combination. SOLUS-1003, [82]. In particular, a POSITA would have readily understood, with simple calculation, that the sum of certain ranges of three values provided in Hanafusa-Dobashi falls within the “binding coefficient”

requirement in [1d] (“Binding coefficient = $R_p/\mu\text{m}$ + peak density/30 + amount of attachment of Cr/(mg/m^2)”). SOLUS-1003, [82]-[83].

Again, Hanafusa-Dobashi has the following values of three parameters:

- The peak height is smaller than the range from 1.0 to 2.0 μm ;
- The peak density is smaller than 10.3 to 28.6 peaks per 4 mm; and
- The amount of attachment of Cr has a ceiling of 2.6 to 4.0 mg/m^2 with no floor.

As explained by Dr. Josefowicz and summarized in Tables 1 and 2 below, several values selected from the ranges of these parameters would safely fall with the claimed range (1.5 to 9.4) of the “binding coefficient” of claim 1. SOLUS-1003, [84]. By way of example, in Example 1.1 of Table 1 below, the following calculation results in the binding coefficient of 4.9, which falls within the claimed range:

- Binding coefficient (4.9) = $R_p/\mu\text{m}$ (1.99 μm) + peak density/30 (10.3/30) + amount of attachment of Cr/(mg/m^2) (2.6 mg/m^2)

EXAMPLE	$R_p/\mu\text{m}$	Peak Density/30	Cr/(mg/m^2)	Mathematical Expression 1
1.1	1.99	0.3	2.6	4.9
1.2	1.99	0.3	4.0	6.3
1.3	1.99	1.0	2.6	5.5
1.4	1.99	1.0	4.0	6.9

Table 1: binding coefficient values assuming $R_p/\mu\text{m}$ of 1.99 (e.g., < 2.0 μm as disclosed by Hanafusa)

Even assuming peak density values approaching zero (due to the use of more stringent $\pm 0.5 \mu\text{m}$ discrimination lines, which would disqualify most if not nearly all peaks for peak density purposes), the Hanafusa-Dobashi electrolytic copper foil would not be precluded from meeting the binding coefficient limitation. SOLUS-1003, [85].

By way of example, in Example 2.1 of Table 2 below, the following calculation results in the binding coefficient of 4.7, which falls within the claimed range:

- Binding coefficient (4.7) = $R_p/\mu\text{m}$ (1.99 μm) + peak density/30 (2.6/30) + amount of attachment of Cr/(mg/m^2) (2.6 mg/m^2)

EXAMPLE	$R_p/\mu\text{m}$	Peak Density/30	Cr/(mg/m^2)	Mathematical Expression 1
2.1	1.99	0.1	2.6	4.7
2.2	1.99	0.1	4.0	6.1
2.3	1.99	0.2	2.6	4.8
2.4	1.99	0.2	4.0	6.2

Table 2: binding coefficient values assuming $R_p/\mu\text{m}$ of 1.99 and lower peak density values due to use of $\pm 0.5 \mu\text{m}$ discrimination lines

Similarly, other examples in Tables 1 and 2 for the electrolytic copper foil of the Hanafusa-Dobashi combination satisfy the recited range of “binding coefficient” (1.5 to 9.4). SOLUS-1003, [86]-[87]. These specific “binding coefficient” values in Hanafusa-Dobashi are thus a relevant disclosure for the claimed range of “binding coefficient.” *Id.*; *Ineos USA LLC v. Berry Plastics*

Corp., 783 F.3d 865, 869 (Fed. Cir. 2015) (“When a patent claims a range, as in this case, that range is anticipated by a prior art reference if the reference discloses a point within the range”); *see also Titanium Metals Corp. of Am. V. Banner*, 778 F.2d 775, 782 (Fed. Cir. 1985); *In re Petering*, 301 F.2d 676, 682 (1962). Thus, Hanafusa-Dobashi renders obvious through the electrolytic copper foil in the combination a “binding coefficient” of 1.5 to 9.4.

Alternatively and additionally, the range of “binding coefficient” values (minimum of 4.9 to maximum of 6.9) for the electrolytic copper foil of the Hanafusa-Dobashi combination overlaps the recited range of “binding coefficient” (1.5 to 9.4), while the ’014 Patent fails to provide any indication of criticality or unexpected results associated with the claimed range of “binding coefficient.” SOLUS-1003, [88]. The overlapping range of “binding coefficient” values of the electrolytic copper foil of the Hanafusa-Dobashi combination thus presents a *prima facie* case of obviousness of the claimed range. *See In re Peterson*, 315 F.3d 1325, 1329 (Fed. Cir. 2003) (“A *prima facie* case of obviousness typically exists when the ranges of a claimed composition overlap the ranges disclosed in the prior art”); *In re Geisler*, 116 F.3d 1465, 1469-70 (Fed. Cir. 1997) (“When an applicant seeks to overcome a *prima facie* case of obviousness by showing improved performance in a range that is within or overlaps with a range disclosed in the prior art, the applicant must ‘show that the [claimed] range is *critical*, generally by showing that

the claimed range achieves unexpected results relative to the prior art range”

(quoting *In re Woodruff*, 919 F.2d 1575, 1578 (Fed. Cir. 1990) (alteration and emphasis in original))).

(ii) Claim 4

The Hanafusa-Dobashi electrolytic copper foil would have the claimed yield strength, as taught by Hanafusa’s proof stress. SOLUS-1003, [89]. For example, Hanafusa describes that the foil’s “0.2% proof stress is 18 to 25 kgf/mm².” SOLUS-1004, Abstract, cls 1, 6, [0009], [0013], [0026], [0034], [0045], [0060]. A POSITA would have readily understood that “0.2% proof stress” corresponds to a yield strength measured at normal temperature. SOLUS-1003, [89]. “[T]he stress required to produce an offset (plastic deformation) amount of 0.2 percent is generally used for the standard strength equivalent to the yield point, which is called ‘**0.2% offset yield strength**’ or ‘**0.2% proof stress**.’ Both yield point and 0.2% offset yield strength are often referred simply to as ‘**yield strength**’ or ‘yield stress.’” SOLUS-1017, 1-2.

In particular, Hanafusa provides several examples of “0.2% proof stress” that fall within the recited range of “yield strength” (21 to 49 kgf/mm²), such as 25.0 (“Example 1”) and 23.2 (“Example 2”). SOLUS-1004, [0045]. Therefore, these specific “0.2% proof stress” values (the same as “yield strength” that is “measured at normal temperature”) disclosed by Hanafusa-Dobashi are a relevant

disclosure for the recited range of yield strength. SOLUS-1003, [90]; *see Ineos USA*, 783 F.3d at 869; *Titanium Metals*, 778 F.2d at 782; *In re Petering*, 301 F.2d at 682. Thus, Hanafusa-Dobashi renders obvious through the electrolytic copper foil in the combination a yield strength of 21 to 49 kgf/mm².

Alternatively and additionally, the '014 Patent provides no indication of criticality or unexpected results associated with the claimed range of the yield strength (21 to 49 kgf/mm²). SOLUS-1003, [91]. Therefore, Hanafusa's 0.2% proof stress (from 18 to 25 kgf/mm²), which overlaps the recited range of yield strength (21 to 49 kgf/mm²), presents a *prima facie* case of obviousness of the claimed range. *See In re Peterson*, 315 F.3d at 1329; *In re Geisler*, 116 F.3d at 1469-70.

(iii) Claim 8

Hanafusa-Dobashi renders obvious negative electrode active material layers on both surfaces of the foil. SOLUS-1003, [92]. In particular, Hanafusa contemplates that “negative-electrode material” should be applied “uniformly on both sides of the copper foil.” SOLUS-1004, [0061]. Indeed, Hanafusa adjusts its surface roughness (Rz) to be equal to or smaller than 2.0 μm to accomplish the uniform application of negative-electrode material on both sides of the foil. *Id.*

Further, a POSITA would have understood or found it obvious that Hanafusa's “negative electrode material” is the “negative electrode *active*

material” of claim 8. SOLUS-1003, [93]. In particular, the ’014 patent specification discloses that a “negative electrode active material layer 120 may include a carbon-based active material, such as **graphite** or coke.” SOLUS-1001, 7:5-11. This is consistent with Hanafusa’s negative electrode material, which is described as having “[n]egative-electrode material (**graphite** or carbon). SOLUS-1004, [0046]. The ’014 patent further discloses that the “negative electrode active material layer” “may further include a conductive agent and a **binder**,” consistent with Hanafusa’s negative electrode material, which is described as including a “[b]**inder** (polyvinylidene fluoride).” SOLUS-1001, 7:17-18; SOLUS-1004, [0046]. Although the ’014 patent further discloses that the “negative electrode active material layer” “**may** include least one metal selected from the group consisting of Si, Ge, Sn, Li, Zn, Mg, Cd, Ce, Ni, and Fe,” the specification does not require it. SOLUS-1001, 7:10-13. As such, Hanafusa’s “negative electrode material,” consisting of graphite or carbon, a binder, and provided as a layer on both sides of the Hanafusa-Dobashi electrolytic copper foil, is the “negative electrode active material” as recited in claim 8, and renders obvious the claimed negative electrode active material layers on both surfaces of the foil. SOLUS-1003, [93].

B. [GROUND 1B]—Claim 2 is Obvious Over Hanafusa-Dobashi-Cheng

1. Overview of Cheng

Cheng describes “electrolytic copper foil” that is “particularly suitable for the application of a lithium ion secondary battery,” with a “shiny side and a matte side” where, based on the sum of the texture coefficients “of a (111) surface, a (200) surface, a (220) surface and a (311) surface of the electrolytic copper foil,” the “sum of the texture coefficients of the (220) surface and the (311) surface of the electrolytic copper foil is greater than 60%.” SOLUS-1007, Abstract; SOLUS-1003, [94]-[96]. The electrolytic copper foil has “completely different crystalline phase structure” such that it is not easy for it “to break or fracture during the charging-discharging cycles” such that “the life of a battery is thus increased.” SOLUS-1007, 3:32-40. The electrolytic copper foil has a roughness of the matte side “less than 2 μm , such that the **roughness difference between the shiny side and the matte side is similar**” and thus “particularly suitable to be used. . . for a lithium ion secondary battery.” SOLUS-1007, 3:26-28.

Cheng notes that “the (220) surface and (311) surface of the electrolytic copper foil of the present invention have promising crystalline phase characteristics, such that the elongation of the electrolytic copper foil can be greater than 14%. It is further discovered that the electrolytic copper foil with these crystalline phase characteristics resolves the problem of not [being] suitable for use

in a lithium ion secondary battery caused by the high roughness of traditional products.” SOLUS-1007, 3:16-23. Among other description, Cheng discloses TC(220), Rz (ten-point roughness), tensile strength, and elongation for copper foils manufactured according to various process parameters. SOLUS-1007, Table 3.

As Dr. Josefowicz discusses, Cheng’s texture coefficients (TC) correspond to the TC of the ’014 Patent, to within the level of detail provided by the ’014 Patent. SOLUS-1003, [96]. Notably, the TC calculation formulas provided in each document are the same, and the same four crystal planes ((111), (200), (220), and (311)) are considered in TC calculation in each document. SOLUS-1001, cl.2, 5:35-64, 10:64-67, 11:1-5; SOLUS-1007, 2:52-54, 7:25; SOLUS-1003, [96].

2. The Hanafusa-Dobashi-Cheng combination

Hanafusa describes that due to the manufacturing process, electrolytic copper foil in contact with the cathode drum “becomes a mirror surface, while the other surface becomes a rough surface with asperity.” SOLUS-1004, [0022].

Hanafusa notes that such “markedly uneven surface may cause cracks” and that therefore “it is necessary to make the rough surface low-profile; however, there is no particular limitation on how to make the rough surface low-profile. **In other words, all the known methods for making a rough surface low-profile can be used.**” SOLUS-1004, [0023]. Therefore, a POSITA would have investigated the

“known methods,” such as Cheng’s teachings, to implement Hanafusa’s low-profile surface. SOLUS-1003, [97].

By looking to apply the “crystalline phase characteristics” teachings of Cheng to Hanafusa, a POSITA would have recognized that Hanafusa’s “rough surface with asperity” would be further improved to have a “low-profile” through the teachings of Cheng. SOLUS-1003, [98]. The Hanafusa-Dobashi-Cheng combination implements the electrolytic copper foil with the “crystalline phase characteristics” disclosed in Cheng as one such known method for making a rough surface low-profile to ensure that “the roughness difference between the shiny side and the matte side is smaller,” therefore resolving the problem of “high roughness of traditional products.” *Id.*; SOLUS-1007, 3:20-26.

Several other reasons would have motivated a POSITA to implement Hanafusa-Dobashi’s electrolytic copper foil with the “crystalline phase characteristics” as disclosed in Cheng, including such characteristics where, “based on the total sum of the texture coefficients of a (111) surface, a (200) surface, a (220) surface and a (311) surface” of the electrolytic copper foil, the “sum of the texture coefficients of the (220) surface and the (311) surface” is greater than 60%. SOLUS-1003, [99]; SOLUS-1007, Abstract.

For example, a POSITA would have understood the benefits of Cheng’s crystalline phase characteristics that would be implemented in Hanafusa-Dobashi-

Cheng's foil. SOLUS-1003, [100]. In particular, Cheng describes that its crystalline phase characteristics in an electrolytic copper foil would offer advantageous surface roughness properties, which implicate battery performance "in a lithium ion secondary battery," by allowing "an M side with a lower roughness." and thus "increase[ing] the cycle life of the battery." SOLUS-1007, 2:1-11, 43-46. By looking to apply such specific crystalline phase characteristics to Hanafusa-Dobashi, a POSITA would have recognized it as one of "the known methods for making a rough surface low-profile," thus an improvement, since "such a markedly uneven surface may cause cracks." SOLUS-1004, [0023]; SOLUS-1003, [100].

For Hanafusa-Dobashi's electrolytic copper foil with the specific crystalline phase characteristics of Cheng, "the roughness of both sides of the . . . foil . . . is low, and the roughness difference between the two sides is extremely small," and therefore "it is not easy for the electrolytic copper foil to break or fracture during the charging-discharging cycles and the life of a battery is thus increased." SOLUS-1007, 3:32-39. A POSITA thus would have recognized and implemented such specific crystalline phase characteristics of Cheng in furtherance of Hanafusa, which identically sought to avoid "such markedly uneven surface" which "may cause cracks." SOLUS-1004, [0023]; SOLUS-1003, [101].

A POSITA would have been further prompted to pursue this implementation of Cheng's crystalline phase characteristics of electrolytic copper foil into Hanafusa-Dobashi's electrolytic copper foil as doing so is merely the application of known techniques (e.g., using additives in copper sulfate electrolyte for the manufacture of electrolytic copper foil with desirable characteristics) to a known structure (e.g., electrolytic copper foil prepared through electrodeposition process) to yield predictable results (e.g., electrolytic copper foil with desirable characteristics including improved surface roughness properties). SOLUS-1003, [102]; *KSR*, 550 U.S. at 417. A POSITA would have had a reasonable expectation of success in the Hanafusa-Dobashi-Cheng combination, given that both Hanafusa-Dobashi and Cheng already describe manufacture of electrolytic copper foils with desirable surface roughness properties to avoid "cracks," "break or fracture during the charging-discharging cycles" thereby increasing life of a battery. SOLUS-1004, [0023]; SOLUS-1007, 3:32-39; SOLUS-1003, [102].

3. Analysis of Claim 2

Hanafusa-Dobashi-Cheng renders obvious claim 2. SOLUS-1003, [103]. As discussed in Section IV.B.2 (Hanafusa-Dobashi-Cheng combination) above, Hanafusa recognizes the need "to make the rough surface low-profile," while recognizing that there is "no particular limitation on how to make the rough surface low-profile." SOLUS-1004, [0023]. Moreover, the combination based on Cheng

renders obvious an electrolytic copper foil with specific “crystalline phase characteristics,” such that “the roughness of both sides of the electrolytic copper foil [is] low and the roughness difference between both sides [are] extremely small,” and therefore “not easy for the electrolytic copper foil to break . . . during the charging-discharging cycles.” SOLUS-1007, 10:27-34.

Through Cheng’s disclosure, a POSITA would have found it obvious to use electrolytic copper foil with a texture coefficient of a (220) plane (as defined by “Mathematical Expression 2” in claim 2) from 0.49 to 1.28. SOLUS-1003, [104]. In fact, all Embodiments and Comparative Examples as disclosed in Cheng Table 3 describe texture coefficients of (220) planes ranging from 0.70 to 3.20. SOLUS-1007, TABLE 3; SOLUS-1003, [104].

The texture coefficients for all Embodiments and Comparative Examples as disclosed in Cheng Table 3, including for texture coefficients of the (220) plane, are calculated based on Cheng’s “Equation (I)” below, equivalent to “Mathematical Expression 2” of the ’014 patent below as applied to the (220) plane, with the calculations using the same considered crystal planes included in the ’014 patent including crystal planes (111), (200), (220), and (311). SOLUS-1007, 7:20-25, cl.1; SOLUS-1001, cl.2.; SOLUS-1003, [105]. Note that “Equation (I)” is general, applied by Cheng to find texture coefficients for all crystal planes (e.g., (111), (200), (220), and (311)), including for crystal plane (220), while

“Mathematical Expression 2” is specific, since applied in the ’014 patent to find the texture coefficient for crystal plane (220) only, and not for the other crystal planes. SOLUS-1003, [105]. Thus “Equation (I)” is equivalent to “Mathematical Expression 2” as applied to the crystal plane (220). *Id.*

$$TC(hkl) = \frac{I(hkl) / I_0(hkl)}{(1/n) \sum I(hkl) / I_0(hkl)} \quad \text{Equation (I)}$$

Equation (I) of Cheng

$$TC(220) = \frac{\frac{I(220)}{I_0(220)}}{\frac{1}{n} \sum \frac{I(hkl)}{I_0(hkl)}} \quad \text{(Mathematical Expression 2)}$$

Mathematical Expression 2 of the ’014 patent

This range of texture coefficients of (220) planes, as disclosed in Cheng, overlaps considerably with the claimed range of “0.49 to 1.28,” thus renders the claimed range obvious. The Federal Circuit has “consistently held that even a slight overlap in range establishes a prima facie case of obviousness.” *In re Peterson*, 315 F.3d at 1329. The Federal Circuit has also held that it is “an elementary principle of patent law that when, as by a recitation of ranges or otherwise, a claim covers several compositions, the claim is ‘anticipated’ if *one* of

them is in the prior art.” *Titanium Metals*, 778 F.2d at 782 (emphasis in the original).

Test results of the characteristics of electrolytic copper foil									
	Embodi- ment 1	Embodi- ment 2	Embodi- ment 3	Embodi- ment 4	Comparative Example 1	Comparative Example 2	Comparative Example 3	Comparative Example 4	Comparative Example 5
Roughness (Rz) difference between S side and M side (μm)	0.17	0.36	0.26	0.14	0.16	0.14	0.14	0.21	0.66
Weight resistivity (Ωg/m ²)	0.154	0.156	0.154	0.155	0.163	0.162	0.160	0.161	0.155
TC (111)	0.23	0.62	0.33	0.32	1.03	0.98	0.91	1.01	0.30
TC (200)	0.23	0.58	0.30	0.33	1.85	1.51	1.66	1.63	0.18
TC (220)	1.04	1.08	1.07	1.06	0.82	0.72	0.77	0.70	3.20
TC (311)	2.50	1.72	2.30	2.29	0.30	0.79	0.66	0.66	0.32
TC (220) + TC (311)/ TC (total)%	89	70	84	84	28	38	36	34	88
Crack on copper foil after charging- discharging test	No	No	No	No	Yes	Yes	Yes	Yes	Yes

Annotated Table 3 of Cheng (annotated to show TC (220) of Embodiments 1,2,3,4 and Comparative Examples 1,2,3,4)

Specifically, as shown in Cheng Table 3 above, Embodiments 1, 2, 3, 4, as well as Comparative Examples 1, 2, 3, 4, fall within the claimed range. Thus, a POSITA would have understood that the Hanafusa-Dobashi-Cheng combination has the claimed texture coefficient of 0.49 to 1.28, as taught by Cheng. SOLUS-1003, [106].

Additionally, there is no indication in the '014 patent that the claimed range of texture coefficients of a (220) plane shows “unexpected results relative to the prior art range,” and therefore the '014 patent fails to show that the claimed range is critical, thus fails to overcome the prima facie case of obviousness. SOLUS-

1003, [107]-[108]; *In re Peterson*, 315 F.3d at 1330-31. The Federal Circuit has held that “where the general conditions of a claim are disclosed in the prior art, it is not inventive to discover the optimum or workable ranges by routine experimentation” *E.I. DuPont de Nemours & Co. v. Synvina C.V.*, 904 F.3d 996, 1006 (Fed. Cir. 2018).

Here, the '014 Patent provides no discussion or any evidence that the claimed range of texture coefficients of a (220) plane shows unexpected results relative to the prior art range or that it is more than the discovery of an optimum range by routine experimentation. SOLUS-1003, [108]. On the other hand, the general significance of specific “crystalline phase characteristics,” including the texture coefficient of the (220) plane, was known. SOLUS-1009, Abstract (“The (220)-oriented Cu foils possessed a superior combination of tensile strength and ductility”). Cheng as prior art also discloses the general significance of specific “crystalline phase characteristics,” including specifically the texture coefficients of (220) planes and provides a range of values overlapping the claimed range such that “the roughness of both sides of the electrolytic copper foil [are] low and the roughness difference between both sides [are] extremely small.” SOLUS-1007, 10:27-34; SOLUS-1003, [108]. Therefore, the general conditions of the claimed range of texture coefficient of a (220) plane were disclosed in prior art, and the significance of the texture coefficient of a (220) plane was already recognized in

prior art. SOLUS-1003, [108]. Since the '014 patent's range of values fail to show unexpected results relative to prior art, since they are not more than the discovery of the optimum or workable range of values, and since the general significance of "crystalline phase characteristics" had already been disclosed, the Hanafusa-Dobashi-Cheng combination renders obvious the '014 patent's range of values for the texture coefficient of a (220) plane. *Id.*

C. [GROUND 1C]—Claim 3 is Obvious over Hanafusa-Dobashi-Kim

1. Overview of Kim

Kim describes a "copper foil for a current collector of a lithium secondary battery, wherein factors such as surface roughness, **weight deviation**, tensile strength, elongation, and thickness are optimized. . . to decrease the generation of wrinkles at the surface of the copper foil." SOLUS-1008, 2:4-9; SOLUS-1003, [109]. Kim teaches that prevention of wrinkles at the surface of the foil makes it "possible to form a uniform coating surface and prevent a short circuit when being coated with active material." *Id.*, 2:30-35. Thus, Kim describes optimizing factors including surface roughness (e.g., "surface roughness (Rz-JIS) of 2 μm or less") and weight deviation (e.g., "weight deviation of 3% or less") for a copper foil which prevents wrinkles at the surface of the foil, thus allowing a uniform coating surface. SOLUS-1008, cl. 1.

2. The Hanafusa-Dobashi-Kim combination

In addition to the surface roughness characteristics described in Hanafusa-Dobashi, the electrolytic copper foil in Hanafusa-Dobashi-Kim would have a weight deviation of 3% or less in lateral direction of the foil, as taught by Kim, thereby preventing wrinkles at the surface of the foil as intended by Kim and making it possible to form a uniform coating surface as intended by Hanafusa. SOLUS-1008, cl. 1; SOLUS-1004, [0061] (“apply[ing] the “negative-electrode material uniformly on both sides of the copper foil”); SOLUS-1003, [110].

Several reasons would have motivated a POSITA to implement the Hanafusa-Dobashi-Kim combination. SOLUS-1003, [111]. For example, a POSITA would have understood that Kim’s teaching of the weight deviation (synonymus with copper foil uniformity) would facilitate the purpose of Hanafusa-Dobashi. SOLUS-1003, [112]. Hanafusa recognizes the importance of surface roughness and adhesion of negative-electrode material on the surface of the foil. SOLUS-1004, [0029]; SOLUS-1003, [112]. Similarly, Kim identifies the disadvantages of active material being not uniformly coated “due to the irregularity of the surface,” which would “cause short-circuit or separate the active material from the copper foil during a charging or discharging process.” SOLUS-1008, 1:57-61. Therefore, Kim describes that an electrolytic copper foil with weight deviation of 3% or less and no wrinkles makes it “possible to form a uniform

coating surface and prevent a short circuit when being coated with active material.”

SOLUS-1008, 2:30-35. As such, a POSITA would have understood that the electrolytic copper foil with this weight deviation in the Hanafusa-Dobashi-Kim would benefit from Kim’s weight deviation and accomplish what’s intended in Hanafusa—to ensure adhesion of the electrolytic copper foil to a negative-electrode material. SOLUS-1003, [112].

Further, Hanafusa-Dobashi’s foil would further benefit from Kim’s weight deviation features. SOLUS-1003, [113]. For example, Kim describes that the weight deviation of 3% or less in lateral direction prevents “property deviations” at the surface of the copper foil, which may “increase the number of wrinkles and make properties of the current collector irregular.” SOLUS-1008, 4:24-29; SOLUS-1003, [113].

Moreover, a POSITA would have understood that weight deviation is linked to property deviations such as surface roughness and microscopic copper crystal orientation and texture coefficient, thereby making weight deviation a parameter that encompasses the physical and crystallographic properties that are critical to adhesion and the formation of non-uniformity in the copper foil that can lead to wrinkles. SOLUS-1003, [114]. In Hanafusa-Dobashi-Kim, Kim’s teaching of weight deviation of 3% or less and no wrinkles would enable Hanafusa-Dobashi’s copper foil to have “excellent peel strength” because “sufficient adhesive force is

ensured when the copper foil is contacted with anode active material.” SOLUS-1008, 5:45-50; SOLUS-1003, [114].

A POSITA would also understand that in Hanafusa-Dobashi-Kim, Kim’s teaching of weight deviation of 3% or less and no wrinkles would enable Hanafusa-Dobashi’s copper foil to make possible “a lithium secondary battery that may stably keep a battery capacity.” SOLUS-1008, 5:48-51; SOLUS-1003, [115].

This implementation is merely the application of known techniques (foil with weight deviation of 3% or less) to a known structure (the Hanafusa-Dobashi composition and surface structure) to yield predictable results (electrolytic copper foil with a uniform coating surface—e.g., no wrinkles—allowing for “excellent peel strength” due to “sufficient adhesive force” when the copper foil contacts anode active material for a lithium secondary battery). SOLUS-1008, 5:45-50; *KSR*, 550 U.S. at 417. The copper foil of Kim is very similar to the structural, chemical, and metallurgical characteristics to that of Hanafusa-Dobashi. SOLUS-1003, [116]. The copper foil of Kim, like the copper foil of Hanafusa-Dobashi as discussed in Section IV.A.3., is made “by means of electroplating,” for use as “material of the anode current collector” in a “lithium secondary battery.” SOLUS-1008, 1:30-45. As such, the copper foil of Kim, like that of Hanafusa-Dobashi, is “coated with a protective layer. . . so as to ensure corrosion resistance.” *Id.*, 1:48-50. Identical to the copper foil of Hanafusa-Dobashi, Kim’s copper foil is “coated

with active material” and has factors such as “surface roughness” that are “optimized” to ensure “adhesion of active material to the surface of the copper foil.” *Id.*, 1:39, 3:1-5; 3:50-4:1. Thus, the copper foil of Kim shares a known structure with that of Hanafusa-Dobashi. SOLUS-1003, [116].

A POSITA would have had a reasonable expectation of success in making Hanafusa-Dobashi’s electrolytic copper foil with weight deviation of 3% or less in lateral direction as taught by Kim. SOLUS-1003, [117]. Indeed, a POSITA would have recognized that, according to Hanafusa, the electrolytic copper foil surface characteristics—e.g., surface roughness—would affect “adhesion to a negative-electrode material” (SOLUS-1004, [0012]) and that wrinkling, which is one such copper foil characteristic, is affected by weight deviation along with surface roughness and texture coefficient. SOLUS-1003, [117]; SOLUS-1008, 1:52-57. With this understanding, a POSITA would have recognized that the Hanafusa-Dobashi-Kim combination would require only routine implementation techniques, which were well within the POSITA’s skill. SOLUS-1003, [117]. Indeed, the composition of Kim’s electrolytic copper foil is generally similar to that of the Hanafusa-Dobashi electrolytic copper foil as both are intended for use as current collector of a lithium secondary battery. *Id.*; SOLUS-1008, 1:52-57, 5:45-50; SOLUS-1004, [0001].

3. Analysis of Claim 3

Hanafusa-Dobashi-Kim renders claim 3 obvious. SOLUS-1003, [118]. In the combination, the “electrolytic copper foil” is implemented with foil surface characteristics prescribed in furtherance of improved “adhesion to a negative-electrode material” or “sufficient adhesive force” when the copper foil “is contacted with anode active material.” SOLUS-1004, [0029]; SOLUS-1008, 5:45-50; SOLUS-1003, [118]. Such foil surface characteristics prescribed include, based on Kim, at least foil with “weight deviation of **3% or less.**” SOLUS-1008, 2:24-25, 4:24-30, 6:44-45, Abstract. Such range of weight deviation, as disclosed in Kim, overlaps considerably with the claimed range of “weight deviation in lateral direction of the electrolytic foil is **less than 3%,**” thus renders the claimed range obvious. SOLUS-1001, cl. 3; SOLUS-1003, [118]. The Federal Circuit has “consistently held that even a slight overlap in range establishes a prima facie case of obviousness.” *In re Peterson*, 315 F.3d at 1329. The Federal Circuit has also held that it is “an elementary principle of patent law that when, as by a recitation of ranges or otherwise, a claim covers several composition, the claim is ‘anticipated’ if *one* of them is in the prior art.” *Titanium Metals*, 778 F.2d at 782 (emphasis in the original).

Additionally, there is no indication in the ’014 patent that the claimed range of weight deviation shows “unexpected results relative to the prior art range” and

therefore fails to show that the claimed range is critical, thus fails to overcome the prima facie case of obviousness. *In re Peterson*, 315 F.3d at 1330-31; *E.I. DuPont*, 904 F.3d at 1006.

Here, the '014 Patent provides no discussion or any evidence that the claimed range of weight deviation shows unexpected results relative to the prior art range or that it is more than the discovery of an optimum range by routine experimentation. SOLUS-1003, [119]-[120]. On the other hand, Kim as prior art disclosed the general significance of specific factors, including weight deviation, in furtherance of a copper foil for a current collector of a lithium secondary battery with “sufficient adhesive force” when the foil is “contacted with anode active material.” SOLUS-1008, 5:45-50. Therefore, the general conditions of the claimed range of weight deviation was disclosed in prior art; the significance of weight deviation was recognized in prior art. Since the '014 patent's range of values fail to show unexpected results relative to prior art, since they are not more than the discovery of the optimum or workable range of values, and since the general significance of “weight deviation” has already been disclosed, the Hanafusa-Dobashi-Kim combination renders as obvious the '014 patent' range of values for weight deviation. SOLUS-1003, [120].

Indeed, Kim's measurements and calculations used to determine weight deviation of an electrolytic copper foil are substantially the same (if not identical)

as those in the '014 patent. SOLUS-1003, [121]. In particular, the '014 patent describes:

“the weight deviation in lateral direction of the electrolytic copper foil is calculated by cutting the copper foil to an area of 5 cmX5 cm to make a sample, measuring the weight of the sample and converting the measured weight into a weight value of the copper foil per unit area, repeatedly performing the sample cutting process in the lateral direction of the copper foil, measuring weight values of the copper foil of respective samples, and calculating a standard deviation.”

SOLUS-1001, 6:25-35. This is identical to the measurements and calculations disclosed by Kim to determine weight deviation:

“the weight deviation is obtained by cutting a copper foil by an area of 5 cmX5 cm to make a test piece, measuring weight of the test piece and converting the weight into a weight of the copper foil per a unit area, cutting the test piece along a width direction of the copper foil, repeating the above processes to measure weights of copper foils of every test piece, and then calculating a standard deviation.”

SOLUS-1008, 4:28-36. Because the measurements and calculations for weight deviation as disclosed by Kim are identical to that of the '014 patent, Kim, as implemented in the combination, provides the “weight deviation in lateral direction” limitation of the '014 patent. SOLUS-1003, [122].

D. [GROUND 1D]—Claims 5 and 6 are Obvious Over Hanafusa-Dobashi-Lee

1. Overview of Lee

Lee describes “an electrolytic copper foil for a secondary battery” with “excellent flexural endurance” and “a method for producing the electrolytic copper

foil.” SOLUS-1006, Abstract; SOLUS-1003, [123]. Lee describes the need for such an electrolytic copper foil with “excellent flexural endurance” “such that the copper foil can withstand a stress due to the expansion and contraction of the active material layer when charging/discharging of the battery is repeated.” SOLUS-1006, 2:17-25. Lee’s electrolytic copper foil is “produced from a plating solution, containing total organic carbon (TOC), cobalt and arsenic.” *Id.*, Abstract.

2. The Hanafusa-Dobashi-Lee combination

Hanafusa-Dobashi-Lee would have provided a method of manufacturing an electrolytic copper foil, using a plating solution with a specified amount of total organic carbon, cobalt and arsenic, as taught by Lee. SOLUS-1004, [0037]; SOLUS-1006, Abstract; SOLUS-1003, [124]. Notably, Hanafusa-Dobashi describes a method of manufacturing an electrolytic copper foil, including (1) the electroplating of copper film (2) through use of a rotary negative electrode drum, (3) a positive electrode plate, (4) the application of a current between them (5) while disposed in an electrolytic solution contained in an electrolytic bath, and (6) the provision of a rust-proof chromium layer on the surface of the copper film to prevent surface oxidation. SOLUS-1003, [124]; SOLUS-1004, [0013], [0016], [0018]-[0021], [0037], Fig. 1; SOLUS-1005, 8:49-64. While the electrolytic solution as disclosed by Hanafusa-Dobashi would contain nitride-containing organic compound (*see* SOLUS-1004, [0037]), Hanafusa-Dobashi does not

expressly describe specifics of the solution being used. SOLUS-1003, [125]. As part of the investigation to implement Hanafusa-Dobashi's manufacturing method, a POSITA would have looked for other references, such as Lee, to determine an electrolytic solution. *Id.* A POSITA would have recognized that the method of manufacture in Hanafusa-Dobashi would be improved through adoption of Lee's teachings of using a plating solution with a specified amount of total organic carbon, cobalt and arsenic. *Id.*; SOLUS-1006, Abstract; *see infra* Section IV.D.3 (analysis of claims 5-6).

Several reasons would have prompted a POSITA to implement the manufacture of the electrolytic copper foil using Lee's teachings of plating solution. SOLUS-1003, [126].

Among others, a POSITA would have been motivated to pursue this implementation to achieve additional benefits provided by Lee's manufacturing solutions. SOLUS-1003, [127]. For example, a POSITA would have appreciated that Lee's disclosure of a plating solution would allow "copper foil physical properties to be uniform," thus improving "flexural endurance" of the copper foil. *Id.*; SOLUS-1006, 2:37-41, 4:61-67, 6:5-21. Lee further describes that such an improved flexural endurance would "improve battery lifespan cycle properties and prevent cracking." SOLUS-1006, 4:61-67. Accordingly, a POSITA would have been motivated to produce the electrolytic copper foil for a secondary battery

according to Lee's teachings to add these advantages. SOLUS-1003, [127]. In fact, Hanafusa recognizes the significance of flexibility in electrolytic copper foil to prevent breakage or cracks, as demonstrated by "sufficient proof stress, which is an indicator of resistance to breakage" and confirms that when "flexibility is lost. . . it may cause crack generation." SOLUS-1004, [0026].

A POSITA would have had a reasonable expectation of success in using the total organic carbon, cobalt and arsenic towards manufacture of Hanafusa-Dobashi's copper foil. SOLUS-1003, [128]. Notably, the electrolytic copper foil in Hanafusa-Dobashi and Lee are similar as both are intended for use as current collector of a lithium secondary battery. SOLUS-1004, [0001]; SOLUS-1006, 2:29-35. Further, a POSITA would have understood that the commonly used rotating drum method of manufacturing the electrolytic copper foil in Hanafusa-Dobahis and Lee are similar, since both use the electrolysis method including an electrolytic bath containing electrolyte, a drum (cathode), a metal anode, and the application of an electrical potential between them. SOLUS-1004, [0016]; SOLUS-1006, 1:38-50; SOLUS-1003, [128].

Indeed, a POSITA would have been motivated to pursue this implementation because doing so is merely the application of known techniques (total organic carbon, cobalt and arsenic as an additive in the electroplating solution) to a known structure (Hanafusa's electrolytic copper foil) to yield predictable results

(electrolytic copper foil produced through use of electroplating solution containing total organic carbon, cobalt and arsenic as an additive). SOLUS-1003, [129]; *KSR*, 550 U.S. at 417 (a supposed invention that “simply arranges old elements with each performing the same function it had been known to perform” is obvious).

3. Analysis

(i) Claim 5

[5pre]:

To the extent the preamble is deemed to be limiting, Hanafusa or Hanafusa-Dobashi-Lee describes [5pre]. SOLUS-1003, [130].

Referring to Fig. 1, Hanafusa describes “an electrolytic copper foil manufacturing apparatus.” SOLUS-1004, [0015], [0017]. Further, Hanafusa describes “the copper foil [being] manufactured by the above-described electrolytic copper foil manufacturing apparatus.” SOLUS-1004, [0021]-[0022]; SOLUS-1003, [131]-[132].

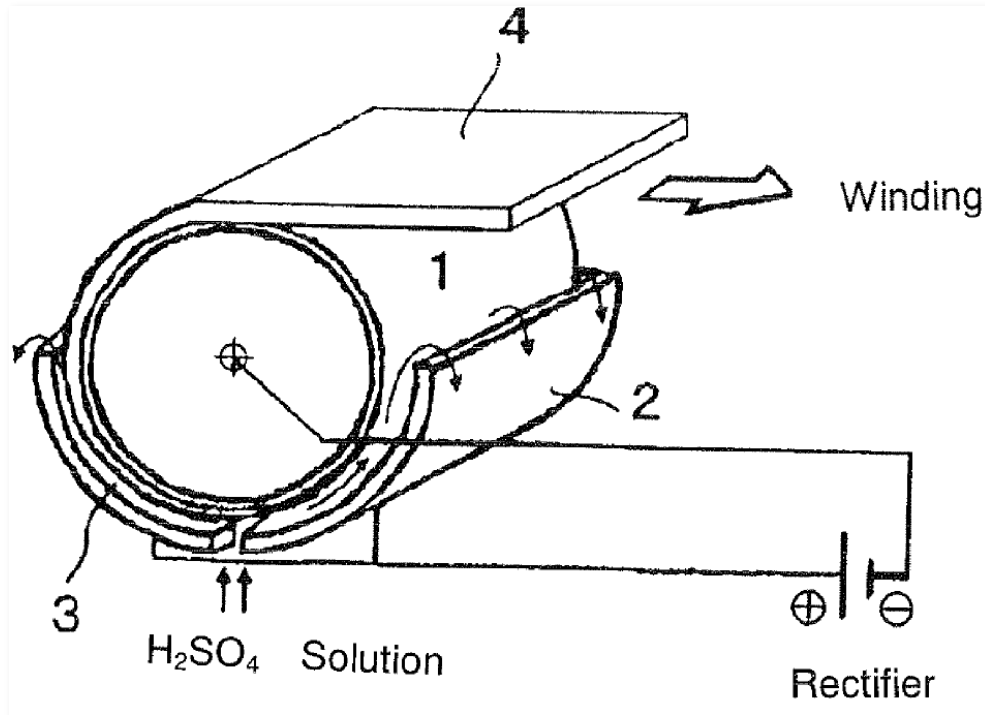


Fig. 1 of Hanafusa

Additionally, Lee describes that, with respect to Fig. 2, “a process of producing an electrolytic copper foil using a drum.” SOLUS-1006, 3:60-62. Lee also provides “a method for producing an electrolytic copper foil for a secondary battery.” *Id.*, 3:8-10. Thus, Hanafusa-Dobashi-Lee discloses a method of manufacturing electrolytic copper foil, as taught by Lee. SOLUS-1003, [133]-[135].

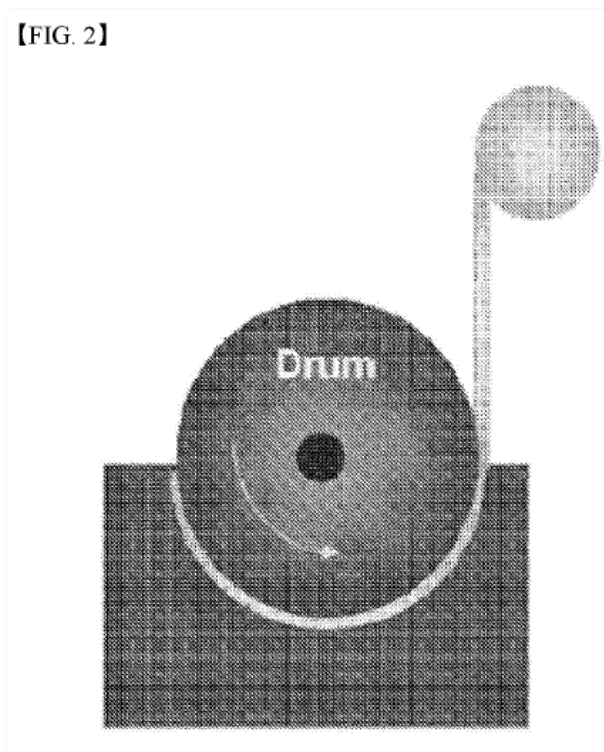


Fig. 2 of Lee

[5a]:

Hanafusa-Dobashi-Lee's manufacturing method includes (a) electroplating a copper film (b) on a rotary negative electrode drum (c) by applying current between a positive electrode plate and the rotary negative electrode drum (d) disposed in an electrolytic solution contained in an electrolytic bath so as to be spaced apart from each other. SOLUS-1003, [136].

Electroplating a Copper Film

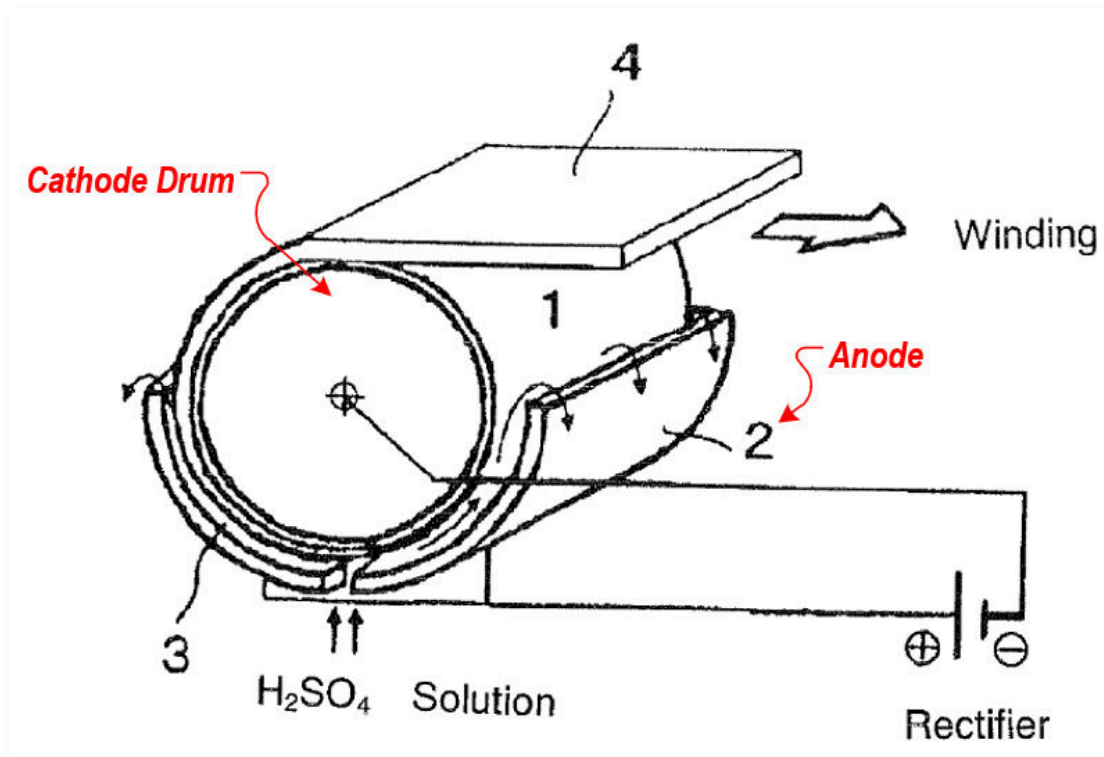
Hanafusa's manufacturing method includes electroplating a copper film. SOLUS-1003, [137]. In Hanafusa, for example, "[a]s the cathode drum 1 rotates,

the thickness of **the copper electrodeposited** from the electrolyte increases.”

SOLUS-1004, [0021], [0016].

Rotary Negative Electrode Drum

Hanafusa's manufacturing method includes a rotary negative electrode drum. SOLUS-1003, [138]. In Hanafusa, for example, “an electrolytic copper foil is continuously manufactured by: using a **rotating metal cathode drum** whose surface is polished, and an insoluble metal anode (positive electrode) placed to surround. . . the lower half part of the cathode drum.” SOLUS-1004, [0016], Fig. 1 (below).



Annotated Fig. 1 of Hanafusa

Hanafusa Fig. 1 shows a “cathode drum 1” which is “designed to rotate” and describes a “specified voltage. . .between the cathode drum 1 and the anode 2 via rectifier.” SOLUS-1004, [0018]-[0020]. In Fig. 1, the rectifier applies a negative voltage to the cathode drum 1, while applying a positive voltage to anode 2. SOLUS-1003, [139].

Applying Current Between Positive Plate and Negative Drum

A POSITA would have understood and found obvious that Hanafusa’s manufacturing method includes applying a current between a positive electrode plate and the rotary negative electrode drum. SOLUS-1003, [140]. In Hanafusa, for example, “[a]n electrolytic copper foil was manufactured using an apparatus, as shown in FIG. 1. . . the **current** density was 50 A/dm².” SOLUS-1004, [0037]. Further, Hanafusa Fig. 1 shows that the rectifier applies a **negative** voltage to the cathode drum 1, while applying a positive voltage to anode 2. *See* SOLUS-1004, Fig. 1, [0019]. Therefore, it would have been obvious to a POSITA that the described **current** was applied between the **positive anode plate** and the **negative cathode drum** of the apparatus, as shown in Hanafusa Fig. 1. SOLUS-1003, [140].

Plate and Drum in Electrolytic Solution

A POSITA would have recognized and found obvious that Hanafusa’s manufacturing method includes the positive anode plate and the negative cathode drum disposed in an electrolytic solution contained in an electrolytic bath so as to

be spaced apart from each other, as disclosed in Hansfusa Fig. 1. SOLUS-1003, [141]. For example, Hanafusa describes that “a **cathode drum** is set in an **electrolytic bath** which contains an **electrolyte**. . . There is a certain **space 3** between the cathode drum 1 and the anode 2. . . the **electrolyte** flows between them.” SOLUS-1004, [0018]-[0019].

[5b]:

A POSITA would have understood and found obvious that Hanafusa’s manufacturing method includes winding the electroplated copper film. SOLUS-1003, [142]. In Hanafusa, “when the thickness of the **electrodeposited copper** reaches a certain value. . . this raw **copper foil 4** is peeled off and **continuously wound up**.” SOLUS-1004, [0021], Fig. 1.

[5c]:

Hanafusa describes that “a rust-proof chromium layer is provided on a surface of the electrolytic copper foil and a deposition amount of chromium in the rust-proof layer is 2.6 to 4.0 mg/m²” to “prevent surface oxidation of the electrolytic copperfoil.” SOLUS-1004, [0013], [0031]-[0033]. As Dr. Josefowicz explains, immersing copper film in an anti-corrosion solution for anti-corrosion treatment was well-known. SOLUS-1003, [143] (citing SOLUS-1013, [0062]). Through these teachings, a POSITA would have understood and found obvious that Hanafusa’s manufacturing method would include immersing the copper film

in an anti-corrosion solution for anti-corrosion treatment for the reasons described in Hanafasa. SOLUS-1003, [143].

[5d]:

The manufacturing method of Hanafusa-Dobashi-Lee electrolytic copper foil includes a concentration of total carbon of 0.12 g/L or less based on Lee's teachings. SOLUS-1003, [144]. Particularly, Lee's "electrolytic copper foil for a secondary battery ... is produced from a plating solution, containing **total organic carbon** (TOC)." SOLUS-1006, Abstract, Table 3.

It would have been obvious to a POSITA that Lee's "total organic carbon" ("TOC") is the "total carbon" ("TC") as claimed by the '014 patent. SOLUS-1003, [144]. For example, Lee teaches that total organic carbon "and metallic additives such as cobalt. . . are present in a certain amount in a copper electrolytic solution **to maintain the physical properties of the copper foil to be uniform** and thus to have a high flexural endurance." SOLUS-1006, 3:44-49. Similarly, the '014 patent claims that "a copper foil having **great local quality deviation is manufactured**" where "the content of **[total carbon] TC exceeds 0.12 g/L** and the concentration of Co^{2+} exceeds 0.33 g/L." SOLUS-1001, 8:15-22. Thus, a POSITA would have recognized as obvious that Lee's "total organic carbon" ("TOC") was equivalent, or corresponded, to "total carbon" ("TC") as claimed by the '014 patent. SOLUS-1003, [144]. Both are disclosed as being used as an additive along with cobalt/

Co²⁺ to ensure uniformity of physical properties of copper foil and to avoid local quality deviation. *Id.*

As shown in Table 3 below, Lee discloses various ranges of total organic carbon (or total carbon) that fall within the claimed range (i.e., 0.12 g/L or less). *See also* SOLUS-1006, 2:60-63; SOLUS-1003, [145].

TABLE 3

Examples	Bending times In MIT test	Battery lifespan of 300 cycles	TOC concentration	TOC/(Co + As) after dissolving copper foil
Present	120	88.3	340	1.45
Example 1				
Present	200	88.4	220	1.43
Example 2				
Present	111	88.5	101	1.35
Example 3				
Present	168	87.8	1050	1.47
Example 4				
Present	130	88.1	110	1.30
Example 5				
Present	150	88.2	640	1.40
Example 6				
Present	129	88.6	460	1.39
Example 7				
Present	250	87.4	320	1.54
Example 8				
Present	110	87.1	110	1.45
Example 9				
Comparative Example 1	88	82.9 (fracture or peeled)	83	1.11
Comparative Example 2	87	85.4 (fracture or peeled)	98	1.21
Comparative Example 3	86	81.8 (fracture or peeled)	72	1.15
Comparative Example 4	90	82.6 (fracture or peeled)	54	1.27

Annotated Table 3 of Lee

Lee Table 3 describes a range of “concentration of [total organic carbon] TOC contained in the plating solution” including a range of total organic carbon of 54 to 110 ppm, equivalent to 0.05 to 0.11 g/L, which is within the claimed range of 0.12 g/L or less. SOLUS-1003, [146]; SOLUS-1006, 8:10-11, 19-20. Thus, Hanafusa-Dobashi-Lee establishes a *prima facie* case of obviousness against the claimed range. *In re Peterson*, 315 F.3d at 1329.

Additionally, the '014 patent provides no discussion or any evidence that the claimed range of total carbon shows unexpected results relative to the prior art range or that it is more than the discovery of an optimum range by routine experimentation. SOLUS-1003, [147]; *In re Peterson*, 315 F.3d at 1330-31; *E.I. DuPont*, 904 F.3d at 1006. On the other hand, Hanafusa-Dobashi-Lee as prior art describes the significance of total organic carbon, including its effect on “crystal structure favorable to flexural endurance. . . of the electrolytic copper foil.” SOLUS-1006, 6:15-21. Thus, the significance of total organic carbon, or total carbon, was already recognized in the prior art. Since the '014 patent's range of total carbon fails to show unexpected results relative to prior art, and since the general significance of total organic carbon effect on “crystal structure favorable to flexural endurance” has already been disclosed, the Hanafusa-Dobashi-Lee combination renders as obvious the '014 patent's range of values for total carbon. SOLUS-1003, [147].

[5e]:

The manufacturing method of Hanafusa-Dobashi-Lee electrolytic copper foil includes a concentration of Co^{2+} of 0.33 g/L or less based on Lee's teachings. SOLUS-1006, Abstract ("an electrolytic copper foil for a secondary battery, which is produced from a plating solution, containing total organic carbon (TOC), **cobalt** and arsenic"). It would have been obvious to a POSITA that "cobalt" included or corresponded to the cation Co^{2+} ("cobalt (II)"), as an additive to a plating solution for manufacture of electrolytic copper foil. SOLUS-1003, [148]. Lee teaches that total organic carbon "and **metallic additives such as cobalt**. . . are present in a certain amount in a copper electrolytic solution **to maintain the physical properties of the copper foil to be uniform** and thus to have a high flexural endurance." SOLUS-1006, 3:44-49. Almost identically, the '014 patent claims that where "the content of [total carbon] TC exceeds 0.12 g/L and the **concentration of Co^{2+} exceeds 0.33 g/L**. . . a copper foil having great **local quality deviation is manufactured**." SOLUS-1001, 8:15-22; SOLUS-1003, [148]. Thus, a POSITA would have recognized as obvious that Lee's "cobalt" was equivalent, or corresponded, to " Co^{2+} " as claimed by the '014 patent. SOLUS-1003, [148]. Both are disclosed as being used as an additive along with total organic carbon/total carbon to ensure uniformity of physical properties of copper foil; to avoid local quality deviation. *Id.*

Further, Lee discloses a range of cobalt (or Co^{2+}) that falls within the claimed range of Co^{2+} . SOLUS-1006, 5:47-53 (“[t]he **cobalt may be contained at 1 mg/L to 50 mg/L**”); 7:65-67 (“cobalt 0.025 g/L”). Therefore, Lee’s range of cobalt from 1 to 50 mg/L overlaps the claimed range of 0.33 g/L or less, and thus Hanafusa-Dobashi-Lee establishes a *prima facie* case of obviousness against the claimed range. *In re Peterson*, 315 F.3d at 1329; SOLUS-1003, [149].

Additionally, the ’014 patent provides no discussion or any evidence that the claimed range of Co^{2+} shows unexpected results relative to the prior art range or that it is more than the discovery of an optimum range by routine experimentation. SOLUS-1003, [150]-[151]; *In re Peterson*, 315 F.3d at 1330-31; *E.I. DuPont*, 904 F.3d at 1006. On the other hand, Hanafusa-Dobashi-Lee as prior art discloses the significance of cobalt, including its use “to maintain the physical properties of the copper foil to be uniform and thus to have a high flexural endurance.” SOLUS-1006, 2:32-36. Thus, the significance of cobalt, or Co^{2+} , as one of “metallic additives ... present in a certain amount in a copper electrolytic solution[,]” was already recognized in the prior art. SOLUS-1006, 3:44-49. Since the ’014 patent’s range of Co^{2+} fails to show unexpected results relative to prior art, and since the general significance of cobalt’s effect on “the physical properties of the copper foil to be uniform” has already been disclosed, the Hanafusa-Dobashi-Lee combination

renders as obvious the '014 patent's range of values for Co^{2+} . SOLUS-1006, 2:32-36; SOLUS-1003, [151].

(ii) Claim 6

The manufacturing method for the Hanafusa-Dobashi-Lee electrolytic copper foil includes a concentration of a nitrogen compound in the electrolytic solution from 3 to 12 ppm as taught by Hanafusa. SOLUS-1003, [152]. Hanafusa discloses “[a]n electrolyte contained ... **2-20 ppm of nitride-containing organic compound.**” SOLUS-1004, [0037]. A POSITA would have understood that “nitride-containing organic compound,” disclosed by Hanafusa, is a nitrogen compound because a nitride is a chemical compound of nitrogen. SOLUS-1003, [152]. This aligns with the '014 patent's disclosure that explicitly references nitride as an additive in its electrolytic solution. *Id.*; SOLUS-1001, 8:26-30.

Further, Hanafusa teaches that a range of nitride-containing organic compound in a plating solution is **2-20 ppm**, which encompasses the claimed range of **3 to 12 ppm**. SOLUS-1004, [0037]; SOLUS-1003, [153]. Thus, Hanafusa-Dobashi-Lee establishes a *prima facie* case of obviousness against the claimed range. *In re Peterson*, 315 F.3d at 1329.

Additionally, the '014 patent provides no discussion or any evidence that the claimed range of nitrogen compound shows unexpected results relative to the prior art range or that it is more than the discovery of an optimum range by routine

experimentation. SOLUS-1003, [154]-[155]; *In re Peterson*, 315 F.3d at 1330-31; *E.I. DuPont*, 904 F.3d at 1006. Since the '014 patent's range of nitride-containing organic compound fails to show unexpected results relative to prior art, and since the use of nitride-containing organic compound in an electrolyte has already been disclosed, the Hanafusa-Dobashi-Lee combination renders obvious the '014 patent's range of values for nitrogen compound.

E. [GROUND 1E]—Claim 7 is Obvious over Hanafusa-Dobashi-Kajihara

1. Overview of Kajihara

Kajihara describes the treatment of copper foil to achieve a “rough surface good in bondability.” SOLUS-1012, 2:52-54; SOLUS-1003, [156]. For example, Kajihara describes “treating copper to make a rough surface” where the copper surface is “immersed into an aqueous solution containing **diethylenetriamine pentaacetic acid and copper ion** and **electrolysis is conducted** by using it as a cathode.” SOLUS-1012, 2:21-29. Kajihara teaches specific ranges of **diethylenetriamine pentaacetate**, PH, temperature, and current density to obtain “bondability of rough surface.” SOLUS-1012, 2:29-50. Thus, Kajihara describes optimizing surface roughness (e.g., “rough surface good in bondability”) for a copper foil, thus improving “satisfactory peelstrength.” *Id.*, 2:54, 43-44.

2. The Hanafusa-Dobashi-Kajihara combination

In addition to meeting the surface roughness characteristics described in the Hanafusa-Dobashi combination, the electrolytic copper foil in the Hanafusa-Dobashi-Kajihara combination would have been subject to a surface treatment process using “an aqueous solution containing diethylenetriamine pentacetic acid,” as taught by Kajihara, making it possible to optimize surface roughness and thus improving “satisfactory peelstrength,” in furtherance of improving the “adhesion of the copper foil” as intended by Hanafusa. SOLUS-1012, 2:26-27, 43-44; SOLUS-1004, [0061] (“if the surface roughness (Rz) is less than 1.0 μm , the adhesion of the copper foil. . . is weak and the copper foil will come off as a result of the charge-discharge test.”); SOLUS-1003, [157].

For several reasons, a POSITA would have been motivated to implement Hanfusa-Dobashi’s electrolytic copper foil subject to the treatment as taught by Kajihara, including electrolysis in an aqueous solution containing diethylenetriamine pentacetic acid. SOLUS-1003, [158].

A POSITA would have understood that Kajihara’s teaching of the copper foil surface roughness treatment would facilitate the purpose of Hanafusa-Dobashi. SOLUS-1003, [159]. For example, Hanafusa recognizes the importance of **surface roughness and adhesion** of negative-electrode material on the surface of the foil. SOLUS-1004, [0029] (“If the surface roughness Rz of the copper foil is less than

1.0 μm , adhesion to a negative-electrode material tends to decrease.”); SOLUS-1003, [159]. Further, a POSITA would have understood based on Hanafusa that “the surface roughness of the electrolytic copper foil can be adjusted by an additive to the electrolyte,” and also that “known methods for adjusting the surface roughness can be arbitrarily used.” SOLUS-1004, [0028].

A POSITA would have understood that Kajihara similarly identifies the disadvantages of having a “**rough surface**” that is “extremely minute” and making it “difficult to obtain **satisfactory peelstrength**.” SOLUS-1012, 2:41-45. A POSITA would have thus recognized that Kajihara’s copper foil surface roughness treatment (e.g., electrolysis in an aqueous solution containing the **additive** diethylenetriamine pentacetic acid) was, as also identified by Hanafusa, a way by which “the surface roughness of the electrolytic copper foil [could] be adjusted by an **additive** to the electrolyte,” making possible a “rough surface good in bondability.” SOLUS-1004, [0028]; SOLUS-1012, 2:53-54; SOLUS-1003, [160]. Therefore, a POSITA would have understood that the electrolytic copper foil that had undergone such surface roughness treatment would benefit from Kajihara’s “rough surface good in bondability” and accomplish what’s intended in Hanafusa, to ensure adhesion of the electrolytic copper foil to a negative-electrode material. SOLUS-1003, [160]; SOLUS-1012, 2:53-54.

Furthermore, a POSITA would have readily recognized that Hanafusa-Dobashi's foil would further benefit from Kajihara's surface roughness treatment (e.g., electrolysis in an aqueous solution containing diethylenetriamine pentacetic acid). SOLUS-1003, [161]. For example, Kajihara describes that such surface treatment would provide electrolytic copper foil with "sufficient peeling strength" as measured in "(Kg/cm)*2." SOLUS-1012, TABLE 2. A POSITA would have recognized additional advantages of Kajihara's surface treatment which include having "few process steps, a short treatment time, and not requiring any high temperature treatment." SOLUS-1012, 2:15-20; SOLUS-1003, [161].

A POSITA would have understood that implementation is merely the application of known techniques where additives in the plating solution can affect the surface roughness characteristics and microcrystal properties (e.g., a foil subject to surface treatment through electrolysis with conventional additives) to a known structure (e.g., the Hanafusa-Dobashi composition) to yield predictable results (e.g., an electrolytic copper foil with optimized surface roughness allowing for "sufficient peeling strength" due to "rough surface good in bondability"). SOLUS-1003, [162]; SOLUS-1012, 2:13, 53-55; *KSR*, 550 U.S. at 417. The copper foil of Kajihara is very similar in structure and characteristics to that of Hanafusa-Dobashi. The copper foil of Kajihara, like the copper foil of Hanafusa-Dobashi as discussed in section IV.A.3, is an "electrolytic copper foil." SOLUS-1012, 3:38-

39; 4:7-10; 5:27-31. The surface of the copper foil of Kajihara, also similar to that of Hanafusa-Dobashi, may be “subject to general chromate treatment.” *Id.*, 2: 64-65. Identical to the copper foil of Hanafusa-Dobashi, the copper foil of Kajihara optimizes factors such as “rough surface” to ensure “sufficient peeling strength.” *Id.*, 2:21-22; 2:12-14. Thus, the copper foil of Kajihara shares a known structure with that of Hanafusa-Dobashi. SOLUS-1003, [162].

A POSITA would have had a reasonable expectation of success in making Hanafusa-Dobashi’s electrolytic copper foil subject to the surface roughness treatment as taught by Kajihara. SOLUS-1003, [163]. Indeed, a POSITA would have recognized that, according to Hanafusa, the electrolytic copper foil surface characteristics—e.g., surface roughness—would affect “adhesion to a negative-electrode material.” SOLUS-1004, [0012]. Based on Hanafusa, a POSITA would have also understood that “the surface roughness of the electrolytic copper foil can be adjusted by an additive to the electrolyte” and that “known methods for adjusting the surface roughness can be arbitrarily used.” SOLUS-1004, [0028]. As such, a POSITA would have recognized the surface treatment of Kajihara—a “known method” where “an additive to the electrolyte” is used to adjust the degree of surface roughness of the electrolytic copper foil—would be in furtherance of the Hanafusa-Dobashi electrolytic copper foil. SOLUS-1003, [163]. Therefore the Hanafusa-Dobashi-Kajihara combination would require only routine

implementation techniques, which were well within the POSITA's skill. *Id.* In fact, the composition of Kim's electrolytic copper foil is generally similar to that of the Hanafusa-Dobashi electrolytic copper foil as both are electrolytic copper foils subject to electrolysis with additives and chromate treatment. SOLUS-1012, 3:38-39; 4:7-10; 5:27-31; 2:64-65; SOLUS-1004, [0001]; SOLUS-1003, [163].

3. Analysis

(i) Claim 7

The manufacturing method for Hanafusa-Dobashi-Kajihara's electrolytic copper foil includes a nitrogen compound comprising DETA based on Kajihara. SOLUS-1003, [164]. For example, Kajihara discloses "an aqueous solution containing **diethylenetriamine pentaacetic acid** and copper ion." SOLUS-1012, 2:25-28. A POSITA would have known that "**diethylenetriamine pentaacetic acid**," disclosed by Kajihara, is equivalent, or corresponds, to diethylenetriamine; both are a chemical compound of nitrogen. SOLUS-1003, [164]. Moreover, both are used as additives in electrolytic solution in furtherance of **increasing adhesiveness of the copper foil**. *Id.*; SOLUS-1001, 8:26-32 ("the content of a nitride in the electrolytic solution may be adjusted to control the yield strength and **adhesion force of the copper foil**."); SOLUS-1012, 2:20-50 ("a method of surface treatment having. . . sufficient peeling strength. . . [the copper surface] is immersed into an aqueous solution containing diethylenetriamine pentaacetic acid. . ."). Thus,

a POSITA would have understood that “diethylenetriamine (DETA)” includes “diethylenetriamine pentaacetic acid,” disclosed by Kajihara. SOLUS-1003, [164].

As discussed in claim 6 above, Hanafusa discloses a range of nitride-containing organic compound in plating solution from 2-20 ppm, which encompasses the claimed range of 3.2 to 12 mg/L. This disclosure of 2-20 ppm range of nitride-containing organic compound combined with Kajihara’s disclosure of diethylenetriamine pentaacetic acid as a nitride compound thus establishes a *prima facie* case of obviousness against the claimed range. SOLUS-1003, [165]; *In re Peterson*, 315 F.3d at 1329 (“even a slight overlap in range establishes a *prima facie* case of obviousness”).

Additionally, there is no indication in the ’014 patent that the claimed range of diethylenetriamine shows “unexpected results relative to the prior art range” and therefore the ’014 patent fails to show that the claimed range is critical, thus fails to overcome the *prima facie* case of obviousness. SOLUS-1003, [166]; *In re Peterson*, 315 F.3d at 1330-31; *E.I. DuPont*, 904 F.3d at 1006.

The argument that Kajihara’s disclosure of a range of diethylenetriamine pentaacetate at 10-100 g/l is contrary to the claimed range of 3.2 to 12 mg/L would fail since the ’014 patent provides no discussion or any evidence that the claimed range of diethylenetriamine shows unexpected results relative to the prior art range, nor that it is more than the discovery of an optimum range by routine

experimentation. SOLUS-1003, [167]. Since the '014 patent's range of nitride-containing organic compound, including that of diethylenetriamine, fails to show unexpected results relative to prior art, and since the use of nitride-containing organic compound including diethylenetriamine in an electrolyte has already been disclosed through Kajihara, Hanafusa-Dobashi-Kajihara renders as obvious the '014 patent's range of diethylenetriamine value. *Id.*

V. SECONDARY CONSIDERATIONS

Petitioner is unaware of any secondary considerations evidence that would affect, let alone overcome, the strong case of obviousness set forth above. To the extent Patent Owner subsequently presents such evidence, Petitioner respectfully requests the right to respond.

VI. PTAB DISCRETION SHOULD NOT PRECLUDE INSTITUTION

A. The *Fintiv* Factors Favor Institution—§ 314(a)

The Board should not discretionarily deny because Petitioner's arguments are compelling with substantial supporting evidence, and further because the *Fintiv* factors do not favor denial.

Factor 1 is neutral; neither party has requested a stay in co-pending litigation.

Factor 2 is neutral based on an expected Final Written Decision (FWD) date in March 2026, which is within four months of the currently scheduled trial date of November 3, 2025. *See* SOLUS-1024. Moreover, Solus's Motion to Transfer that

was filed on June 12, 2024, if successful, will help ensure that the FWD outpaces any trial date, based on the actual schedule or the median time-to-trial. *See* SOLUS-1025.

Factor 3 favors institution; Petitioner has diligently filed this Petition months ahead of the one-year time bar, while the EDTX litigation is still in its early stages and the parties and the court have yet to expend significant resources on invalidity.

Factor 4 favors institution; if the Board institutes trial, Petitioner stipulates not to seek resolution in the district court of the same grounds presented in this Petition.

Factor 5 is neutral; parties in the parallel litigation are the same.

Factor 6 favors institution; the Petition presents a compelling case of invalidity.

B. The *Advanced Bionics* Test Favors Institution—§ 325(d)

This Petition presents new prior art and arguments against the Challenged Claims for which the file history contains no indication that the Office ever previously considered in connection with the '014 Patent. Indeed, none of the references cited in this Petition against the Challenged Claims were previously cited or applied in a rejection during prosecution of the '014 Patent.

VII. PAYMENT OF FEES

Petitioner authorizes the Patent and Trademark Office to charge Deposit Account No. 06-1050 for the fee set in 37 C.F.R. § 42.15(a) for this Petition and further authorizes payment for any additional fees to be charged to this Deposit Account.

VIII. CONCLUSION

The Challenged Claims are unpatentable. Petitioner authorizes charge of fees to Deposit Account 06-1050.

IX. MANDATORY NOTICES UNDER 37 C.F.R. § 42.8(a)(1)

A. Real Party-In-Interest Under 37 C.F.R. § 42.8(b)(1)

Solus Advanced Materials Co., Ltd. is the petitioner, and Volta Energy Solutions Canada Inc., Volta Energy Solutions Europe KFT, Volta Energy Solutions Hungary KFT, and Volta Energy Solutions S.A.R.L. are the Real Parties-In-Interest in this proceeding.

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

Petitioner is not aware of any disclaimers, reexamination certificates or petitions for inter partes review for the '014 Patent. The '014 Patent is the subject of civil action: *SK nexilis Co., Ltd. v. Solus Advanced Materials Co., Ltd. et al.*, Case 2-23-cv-00539 (EDTX), filed November 21, 2023.

C. Lead And Back-Up Counsel Under 37 C.F.R. § 42.8(b)(3)

Petitioner provides the following designation of counsel.

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D. Service Information

Please address all correspondence and service to the address listed above.

Petitioner consents to electronic service by email IPR57533-0003IP1@fr.com.

Respectfully submitted,

Dated: September 20, 2024

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CERTIFICATION UNDER 37 CFR § 42.24

Under the provisions of 37 CFR § 42.24(d), the undersigned hereby certifies that the word count for the foregoing Petition for *Inter Partes* Review totals 13,930 words, which is less than the 14,000 allowed under 37 CFR § 42.24.

Dated: September 20, 2024

/Timothy W. Riffe/

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CERTIFICATE OF SERVICE

Pursuant to 37 CFR §§ 42.6(e)(4)(i) *et seq.* and 42.105(b), the undersigned certifies that on September 20, 2024, a complete and entire copy of this Petition for *Inter Partes* Review and all supporting exhibits were provided via USPS Priority Express Mail, to the Patent Owner by serving the correspondence address of record as follows:

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