

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Patent of: Dae Young Kim, et al.
U.S. Patent No.: 10,480,090 Attorney Docket No. 57533-0001IP1
Issue Date: November 19, 2019
Appl. Serial No.: 15/307,069
Filing Date: Oct. 27, 2016
Title: ELECTROLYTIC COPPER FOIL, CURRENT COLLECTOR
COMPRISING THE SAME, ELECTRODE COMPRISING THE
SAME, SECONDARY BATTERY COMPRISING THE
SAME, AND METHOD FOR MANUFACTURING THE SAME

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**PETITION FOR *INTER PARTES* REVIEW OF UNITED STATES PATENT
NO. 10,480,090 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. 10,480,090 (“the ’090 Patent”)
- SOLUS-1002 Excerpts from Prosecution History of the ’090 Patent (“the Prosecution History”)
- SOLUS-1003 Declaration of Dr. Michael Randall
- SOLUS-1004 U.S. Patent Pub. No. 2013/0108922 (“Shinozaki”)
- SOLUS-1005 C. P. Fabian et al., *Assessment of activated polyacrylamide and guar as organic additives in copper electrodeposition*, Hydrometallurgy 86 (2007) 44-55 (“Fabian”)
- SOLUS-1006 Reserved
- SOLUS-1007 U.S. Patent Pub. No. 2009/0047539 (“Dobashi”)
- SOLUS-1008 U.S. Patent Pub. No. 2006/0191798 (“Sano”)
- SOLUS-1009 U.S. Patent Pub. No. 5834140 (“Wolski”)
- SOLUS-1010 WO Patent Pub. No. WO2015/102323 (“Choi”)
- SOLUS-1011 Certified English Translation of WO2015/102323 and Translator’s Declaration (“Choi”)
- SOLUS-1012 U.S. Patent Pub. No. 2013/0108887 (“Kim”)
- SOLUS-1013 Korean Patent Pub. No. 2012/0003485A (“Toshio”)
- SOLUS-1014 Certified English Translation of KR 2012/0003485A and Translator’s Declaration (“Toshio”)
- SOLUS-1015 Michael B. Griesi, *Characterization of Electrodeposited Copper Foil Surface Roughness for Accurate Conductor Power Loss Modeling*, UNIV. S.C., Dec., 2014 (“Griesi”)

- SOLUS-1016 Gadelmawla, *Roughness parameters*, Journals of Materials Processing Technology 123 (2002) 133-145 (“Gadelmawla”)
- SOLUS-1017 *Surface roughness – Definitions and designation*, Japanese Industrial Standard (JIS) B 0601-1994 (“JIS Standard 1994”)
- SOLUS-1018 *Geometrical Product Specifications (GPS) – Surface texture: Profile method – Terms, definitions and surface texture parameters* (“JIS Standard 2001”)
- SOLUS-1019 *Geometrical Product Specifications (GPS) – Surface texture: Profile method – Terms, definitions and surface texture parameters*, DIN EN ISO 4287 (“DIN Standard”)
- SOLUS-1020 *Operating Instructions MarSurf M 300 + RD 18*, Mahr GmbH, 2008 (“MarSurf M300 instruction manual”)
- SOLUS-1021 *Surface Texture (Surface Roughness, Waviness, And Lay)*, ASME B 46.1 (2009) (“ASME Standard”)
- SOLUS-1022 Japanese Patent Pub. No. JP 2007/217787 (“Matsuda”)
- SOLUS-1023 *Surface Roughness Measurement-Parameters*, Olympus, <https://www.olympus-ims.com/en/metrology/surface-roughness-measurement-portal/parameters/> (“Olympus”)
- SOLUS-1024 B. Bhushan, *Surface roughness analysis and measurement techniques* (2000) (“Bhushan”)
- SOLUS-1025 U.S. Patent Pub. No. 2014/0302281 (“Yacovone”)
- SOLUS-1026 Certified English Translation of JP 2007/217787 and Translator’s Declaration (“Matsuda”)

SOLUS-1027-1028 Reserved

SOLUS-1029 Michael Griesi, *Electrodeposited Copper Foil Surface Characterization for Accurate Conductor Loss Modeling*, DesignCon 2015 Proceedings, January, 2015 (“Griesi Presentation”)

SOLUS-1030 U.S. Patent Pub. No. US20140342178A1 (“Saito”)

SOLUS-1031 U.S. Patent Pub. No. US20100038115A1 (“Matsuda 115”)

SOLUS-1032 Japanese Patent Pub. No. JP 2010/103061A (“Kodaira”)

SOLUS-1033 Japanese Patent Pub. No. JP 2014/065933A (“Yoshiki”)

SOLUS-1034 Korean Patent Pub. No. KR 2014/0078883A and Certified English Translation of KR 2014/0078883A (“Lee”)

SOLUS-1035 Frederick A. Lowenheim, *Modern Electroplating*, John Wiley & Sons, 1974 (“Lowenheim”)

SOLUS-1036 *Measurement of roughness average Ra and peak count R_{Pc} on metallic flat products*, DIN EN 10049:2014-03 (“DIN EN 10049 (2014) Standard”)

SOLUS-1037 September 11, 2024 Email from *SK nexilis* Counsel

SOLUS-1038 *SK nexilis Co., Ltd. v. Solus Advanced Materials Co., Ltd. et al.*, Case 2-23-cv-00539 (EDTX), Proposed Scheduling Order

SOLUS-1039 *SK nexilis Co., Ltd. v. Solus Advanced Materials Co., Ltd. et al.*, Case 2-23-cv-00539 (EDTX), Motion to Transfer Venue

SOLUS-1040 Declaration of June Ann Munford

CLAIM LISTING

Limitation	Claim Language
[1pre]	An electrolytic copper foil for a secondary battery, the electrolytic copper foil comprising:
[1a]	a first surface; and
[1b]	a second surface opposite to the first surface,
[1c]	wherein each of the first and second surfaces has a peak count roughness R _{pc} of 10 to 100,
[1d]	wherein the peak count roughness R _{pc} of each of the first and second surfaces is an average of peak count roughness R _{pc} values measured at randomly-selected three points,
[1e]	the peak count roughness R _{pc} of each point is the number of effective peaks which rise above an upper criteria line of 0.5 μm per unit sampling length of 4 mm in a surface roughness profile obtained according to steel iron test schedule (SEP 1940), and there is at least one valley deeper than a lower criteria line of -0.5 μm between adjacent ones of the effective peaks.
[2]	The electrolytic copper foil according to claim 1, wherein a difference in peak count roughness R _{pc} between the first and second surfaces is 60 or less.
[3]	The electrolytic copper foil according to claim 1, wherein each of the first and second surfaces has a ten-point mean roughness R _{ZJIS} of 2 μm or less.
[4]	The electrolytic copper foil according to claim 1, wherein the electrolytic copper foil has a thickness of 3 to 20μm and tensile strength of 30 to 60 kgf/mm ²
[5pre]	A current collector for a secondary battery, the current collector comprising:
[5a]	the electrolytic copper foil according to claim 1; and
[5b]	a protective layer disposed on the electrolytic copper foil,
[5c]	wherein the protective layer comprises at least one of chromate, benzotriazole and a silane compound.

Limitation	Claim Language
[6]	The current collector according to claim 5, wherein the protective layer is formed on the first and second surfaces of the electrolytic copper foil.
[7pre]	An electrode for a secondary battery, the electrode comprising:
[7a]	a current collector comprising the electrolytic copper foil according to claim 1; and
[7b]	an active material layer disposed on the current collector;
[7c]	wherein the active material layer comprises at least one active material selected from the group consisting of: carbon; a metal (Me) of Si, Ge, Sn, Li, Zn, Mg, Cd, Ce, Ni or Fe; an alloy containing the metal; an oxide of the metal (MeOx); and a chemical compound of the metal and carbon.
[8]	The electrode according to claim 7, wherein the active material layer comprises Si.
[9]	The electrode according to claim 7, wherein the current collector further comprises a protective layer comprising at least one of chromate, benzotriazole and a silane compound, and wherein the protective layer is interposed between the electrolytic copper foil and the active material layer.
[10pre]	A secondary battery comprising:
[10a]	a cathode; an anode; an electrolyte for providing an environment enabling lithium ions to move between the cathode and the anode; and a separator for electrically insulating the cathode from the anode,
[10b]	wherein the anode comprises: a current collector comprising the electrolytic copper 10 foil according to claim 1; and
[10c]	an active material layer disposed on the current collector.
[11]	The secondary battery according to claim 10, further comprising a protective layer comprising at least one of chromate, benzotriazole and a silane compound, wherein the protective layer is interposed between the electrolytic copper foil and the active material layer.

I. INTRODUCTION

Solus Advanced Materials Co., Ltd. (“Petitioner”) petitions for IPR of claims 1-11 (“Challenged Claims”) of U.S. Patent No. 10,480,090 (“the ’090 Patent”).

II. REQUIREMENTS FOR IPR

A. Grounds for Standing

Petitioner certifies that the ’090 Patent is available for IPR. Petitioner is not barred or estopped from requesting this review.

B. Challenge and Relief Requested

Petitioner requests IPR of the Challenged Claims on the below grounds. Dr. Randall provides supporting explanations in his Declaration (SOLUS-1003) cited throughout this petition. SOLUS-1003, ¶¶1-254.

Ground	Claims	Basis for Rejection
1A	1-4, 7, 8, 10	§103: Shinozaki
1B	5, 6, 9, 11	§103: Shinozaki in view of Toshio (or Kim)
2A	1-4, 7, 8, 10	§103: Sano in view of Griesi
2B	5, 6, 9, 11	§103: Sano in view of Griesi and Toshio (or Kim)
3	1-11	§103: Dobashi

As seen below, each reference applied in this Petition predates June 24, 2015 (“Critical Date”), which is the earliest filed foreign application from which the ’090 Patent claims priority. Petitioner does not necessarily agree that the ’090

Patent is entitled to priority to this Critical Date, but has applied references that pre-date the Critical Date and qualify as prior art, as shown below. *See* SOLUS-1040.

Reference	Date	Section
Shinozaki	5/2/2013 (published)	102(a)(1), 102(a)(2)
Toshio	7/19/2013 (published)	102(a)(1), 102(a)(2)
Kim	5/2/2013 (published)	102(a)(1), 102(a)(2)
Griesi	12/15/2014 (published)	102(a)(1)
Sano	08/31/2006 (published)	102(a)(1), 102(a)(2)
Dobashi	5/6/2014 (published)	102(a)(1), 102(a)(2)

III. SUMMARY OF THE '090 PATENT

A. Brief Description

The '090 Patent describes its purported “invention” as relating to an electrolytic copper foil that “can secure secondary batteries with high capacity maintenance,” where the electrolytic copper foil includes a first surface and a second surface opposite to the first surface, the each surface having “a peak count roughness R_{pc} of 10 to 100.” SOLUS-1001, Abstract.

B. Prosecution History

The '090 Patent issued from U.S. Patent App. No. 15/307,069 (“the '069 application”). In the one and only office action of January 10, 2019, the Examiner noted that while the cited art “does not expressly discloses each of the first and

second surfaces has a peak count roughness R_{pc} of 10 to 100” as recited in claim

1, the cited art teaches, among other things, “that the roughness of the foil and relative roughness of the first and second surfaces affect a physical property of the electrode and working parameters of a battery and, as such a result effective.”

SOLUS-1002, 71. In the Office Action, the Examiner asserted that “[i]t would have been obvious . . . the invention was made to optimize the roughness of the foil of [the cited prior art] in order to improve physical characteristics of the electrode and working characteristics of the battery.” *See id.*, 72.

The applicant did not address the Examiner’s assertion regarding result-effective variable. Instead, the applicant merely stated that the “peak” shown in the cited art is “a protrusion shown in a ‘photograph’ taken . . . by an electron microscope” and is thus “totally different” from the “peak” of claim 1, which is “shown in a ‘surface roughness profile’ obtained by measuring the surface roughness of a copper foil according to steel-iron test schedule (SEP 1940).” *See id.*, 62. Therefore, applicant stated that the cited reference does not “teach of suggest an electrolytic copper foil having a peak count roughness (R_{pc}) of the claimed range.” *See id.*, 62. Thereafter, a Notice of Allowance was issued.

C. Level of Ordinary Skill in the Art

A person of ordinary skill in the art relating to the subject matter of the ’090 Patent as of the Critical Date (a “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. SOLUS-1003, ¶10.

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. Here, based on the evidence below and the prior art's description of the claimed elements being similar to that of the '090 Patent's specification, and because the Challenged Claims are obvious under any reasonable interpretation, 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

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. Indeed, the Board has held that

Further, Petitioner may argue in district court that uncertainty regarding the outer bounds of various limitations renders the '090 Patent's claims indefinite. Such lack of clarity, while inhibitive to an infringement analysis, is immaterial here. The obviousness grounds of this petition parallel the '090 Patent's preferred embodiments and thus, do not approach the periphery of claim scope.

IV. THE CHALLENGED CLAIMS ARE UNPATENTABLE

A. [GROUND 1A] – CLAIMS 1-4, 7, 8, and 10 ARE OBVIOUS OVER SHINOZAKI

The sections below provide an introduction to Shinozaki.² SOLUS-1003, ¶18.

it is not paralyzed against assessing whether an ambiguous claim term encompasses similar prior art structure for purposes of an anticipation/obviousness inquiry. *Mylan Pharm. Inc. v. Horizon Pharma USA, Inc.*, IPR2018-00272, Paper 35, 6-8 (PTAB 2019). The Board has regularly compared indefinite claims to the prior art for purposes of considering unpatentability. *See, e.g., Chicago Mercantile Exchange, Inc. v. 5th Market, Inc.*, CBM2013-00027, Paper 33, 3 (PTAB 2014) (holding that the claims were both indefinite and obvious); *SAP America, Inc. v. Lakshmi Arunachalam*, CBM2013-00013, Paper 61, 29 (PTAB 2014).

² Petitioner incorporates this discussion into Ground 1A/1B.

Overview of Shinozaki

Shinozaki describes a current collector for use in secondary batteries. SOLUS-1004, Abstract. In particular, Shinozaki focuses on providing a current collector that is “characterized in that no wrinkles are formed on the collector, the collector does not fracture, the adhesion between the active material and the collector is high, and stable performance can be maintained for a long period of time.” SOLUS-1004, Abstract; SOLUS-1003, ¶19.

More specifically, Shinozaki describes an electrolytic copper foil for the current collector, in which a “surface-roughened layer of copper or copper alloy particles having a particle diameter of 0.1-3 μ m is formed on both surfaces of an untreated copper foil by roughening treatment by means of electrolysis, and the surface-roughened layers on both surfaces have a *surface roughness Rz^3 of 1.0-5 μ m* and a *surface roughness Ra^4 of 0.25-0.7 μ m*, with the *Rz difference* between

³ Rz represents the sum of the absolute values of the five highest peaks and the absolute values of the five lowest valleys, divided by 5. SOLUS-1017, 13; SOLUS-1018, 24-25; SOLUS-1003, ¶21.

⁴ Ra represents the average roughness of a surface, calculated as the mean absolute deviation of the surface profile from the central mean line over a specified sampling length. SOLUS-1016, 1-2; SOLUS-1003, ¶21.

the front and back surfaces being *within 3 μm* and the *Ra differences* between the front and back surfaces being *within 0.3 μm* .”⁵ SOLUS-1004, Abstract, [0029], [0031], [0032]; SOLUS-1003, ¶20.

In sum, Shinozaki attributes adhesion enhancement and other benefits to the following surface roughness characteristics of the electrolytic copper foil:

[1] 10-point mean roughness Rz of 1.0 – 5 μm ;

[2] Ra of 0.25 – 0.7 μm ; and

[3] Both surfaces (matte surface and shiny surface) of electrolytic copper foil exhibiting similar roughness characteristics (e.g., similar Rz and similar Ra).

SOLUS-1004, Abstract, [0029], [0031], [0032], [0073], [0074].

1. Analysis

(i) Claim 1

[1pre]

To the extent the preamble is limiting, Shinozaki renders it obvious. Indeed, Shinozaki specifically discloses “an electrolytic copper foil for a lithium ion secondary battery.” SOLUS-1004, Abstract, [0041]; SOLUS-1003, ¶27.

⁵ All emphases added.

[1a]-[1b]

Shinozaki renders obvious [1a]-[1b]. For example, Shinozaki discloses an “electrolytic copper foil which comprises an untreated copper foil, on the ***both front and back surfaces***,” which correspond to the claimed first surface and second surface opposite to the first surface.⁶ SOLUS-1004, [0031]; SOLUS-1003, ¶28.

[1c]-[1e]

As detailed below, a POSITA would have found [1c]-[1e] to be obvious in view of Shinozaki. SOLUS-1003, ¶29.

1. Rpc (peak count roughness) is a well-recognized measurement parameter shared among various standards, reflecting the number of peak counts (or “effective peaks”) based on (i) an “upper criteria line” and (ii) a “lower criteria line” per (iii) “unit sampling length”

First, various prior art describes that different surface measurement standards, such as ASME B46.1 (1985) and SEP 1940, share the same definition of Rpc as mentioned in the claim language of [1e]. See SOLUS-1025, FIG. 6 (reproduced below), [0050] (“roughness peak count (Rpc) . . . is a two dimensional surface measurement parameter that was measured . . . according to the standards SEP 1940:01.92 and ANSI/ASME B46.1 (1985). For the measurements, the following set points on the device were used: Profile (R): . . . Sampling Length

⁶ All emphases added unless otherwise noted.

(LC): 2.5 mm; Lower Boundary (C2): $-0.5\ \mu\text{m}$ from mean line (M); and Upper Boundary (C1): $0.5\ \mu\text{m}$ from mean line (M). The peak count is dependent on the profile type, and an upper and lower boundary (C1 and C2). The peak count is the number or counts of roughness profile elements exceeding the lower boundary line (C2), and the upper boundary line (C1), immediately afterwards as shown in the FIG. 6 [described below].”); SOLUS-1020, 41; SOLUS-1003, ¶30.

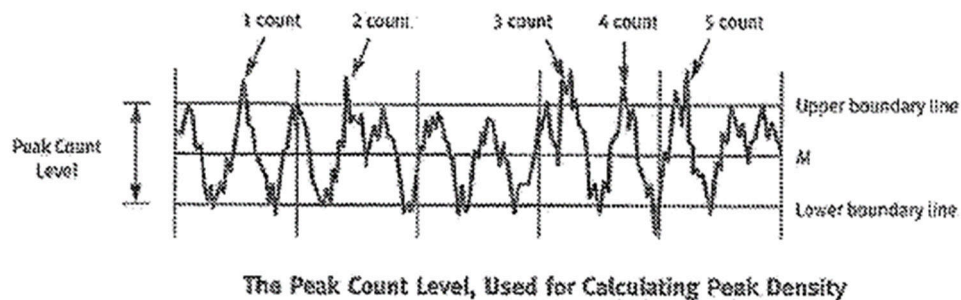


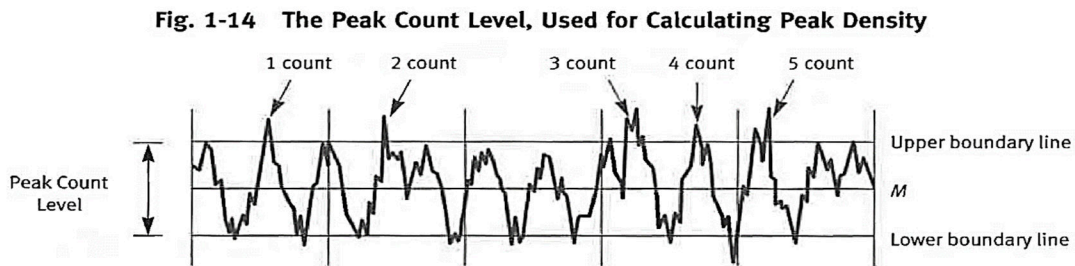
FIGURE 6

SOLUS-1025, FIG. 6

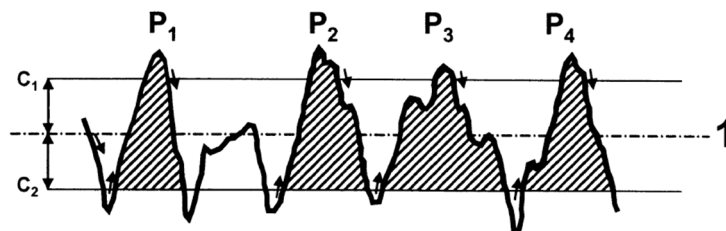
Second, an instruction manual for the surface profile measurement equipment (MarSurf M300), from which the '090 Patent derives R_{pc} data, describes that this R_{pc} definition is shared by various measurement standards, including “EN 10049: 2005, ASME B46. 1 2002; E DIN EN ISO 4287/A1: 200707 (D).” SOLUS-1001, 8:1-5; SOLUS-1020, 41; SOLUS-1003, ¶31.

Third, other measurement standards, such as ASME B46.1 (2009) and DIN EN 10049 (2014), provide the same definition of R_{pc} as recited in the claim language of [1e]. For instance, ASME B 46.1 (2009) refers to “peak density or

“Pc” and describes that “the number of SAE peaks per unit length measured at a specified peak count level over the evaluation length,” in which “SAE peak” is defined as a “profile irregularity wherein the profile intersects consecutively a lower and an upper boundary line . . . located parallel to and equidistant from the profile mean line (see Fig. 1-14).” SOLUS-1021, 21-22, FIG. 1-14 (reproduced below). Further, for instance, DIN EN 10049 (2014) Standard refers to R_{pc} as “number of profile peaks over the full evaluation length l_m ,” where “the height discrimination is performed by consecutively intersecting a lower section line c_2 . . . and an upper section line c_1 . See Figure 3.” SOLUS-1036, 9, FIG. 3 (reproduced below); SOLUS-1003, ¶32.



SOLUS-1021, FIG. 1-14



SOLUS-1036, FIG. 3

Accordingly, Rpc (peak count roughness), as claimed in the '090 Patent, is a well-recognized measurement parameter shared among various standards.⁷

SOLUS-1003, ¶33.

⁷ The '090 Patent provides no substantive discussion of what it means to obtain a surface roughness profile “according to steel iron test schedule (SEP 1940).”

SOLUS-1003, ¶33. Nevertheless, as described above, the application of prior art in this Petition is consistent with how Rpc is described in the '090 Patent. *Id.* It is further consistent with Patent Owner’s allegation of infringement before the district court, where Patent Owner has equated SEP 1940 to DIN EN 10049 (2014). *See* SOLUS-1037 (where SKN-0006820 refers to SOLUS-1036).

Moreover, it is inappropriate to hold the prior art to a stricter standard of disclosure than what is disclosed in the specification of the patent itself. *Id.*; *see In re Epstein*, 32 F.3d 1559, 1568 (Fed. Cir. 1994) (“the Board’s observation that appellant did not provide the type of detail in his specification that he now argues is necessary in prior art references supports the Board’s finding that one skilled in the art would have known how to implement the features of the references and would have concluded that the reference disclosures would have been enabling”).

2. R_{pc} can be obtained from other surface roughness parameters such as R_{sm} or S_m

First, a measurement standard (DIN EN ISO 4287) known to share the same definition of R_{pc} as claimed describes that R_{pc} and R_{sm} are inversely related to each other and thus can be converted. For instance, $R_{pc} = L / R_{sm}$, where L is a reference length (e.g., 4 mm as recited in [1e]) and R_{sm} is a “mean value of the profile element widths X_s .” See SOLUS-1019, 20-21, FIG. 10 (reproduced below); SOLUS-1003, ¶34.

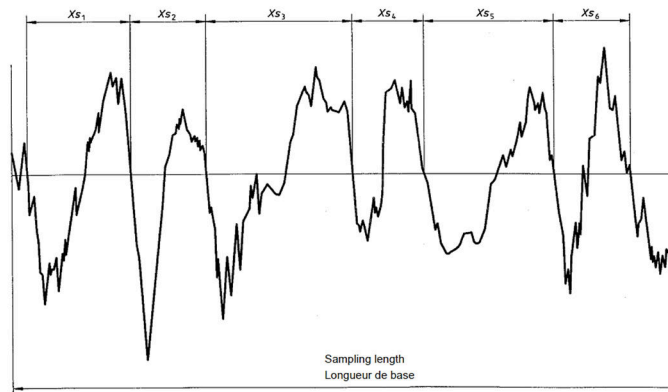


Figure 10 — Width of profile elements
Figure 10 — Largeur des éléments du profil

SOLUS-1019, FIG. 10

In other words, as explained by Dr. Randall, (1) R_{sm} represents the average distance between pairs of consecutive peaks and valleys (exceeding upper and lower height discrimination criteria respectively) on a surface, and (2) dividing the sampling length by R_{sm} gives the number of these peak-valley pairs within that length because it measures how many average-width segments fit into the total length. SOLUS-1003, ¶35.

Second, the roughness tester equipment used in the '090 Patent further confirms that R_{pc} can be converted from R_{sm} , as described in DIN EN ISO 4287. For instance, MahrSurf M300 describes that R_{pc} corresponds to a “[n]umber of profile elements (see R_{sm}) per cm (or per inch) which first exceed the set upper intersection line C1 and then fall short of the lower C2,” where R_{sm} is “[m]ean width . . . of profile elements (formerly: groove spacing).” SOLUS-1020, 41; SOLUS-1003, ¶36.

Lastly, it is noted that R_{sm} is also known as S_m . The MahrSurf M300 equipment of the '090 Patent describes that R_{sm} is shared among different measurement standards, including “JIS B 0601.” SOLUS-1020, 41. According to the JIS B 0601 standard, R_{sm} equates to S_m . SOLUS-1017, 16; SOLUS-1018, 21; SOLUS-1023; SOLUS-1003, ¶37. In the relationships illustrated below, $n = m$ and $S_{mi} = X_{Si}$ as per their respective definitions.

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

where, S_{mi} : spacing of irregularities
 n : number of spacings of irregularity lying within the reference length

PS_m, RS_m, WS_m
 mean value of the profile element widths X_s within a sampling length

$$PS_m, RS_m, WS_m = \frac{1}{m} \sum_{i=1}^m X_{Si}$$

SOLUS-1003, ¶37

Accordingly, R_{pc} can be obtained from other surface roughness parameters, such as R_{sm} or S_m . SOLUS-1003, ¶38

3. Shinozaki discloses S_m values that correspond to R_{pc} values falling within the claimed range of “10 to 100”

As described above, Shinozaki describes an electrolytic copper foil that can enhance adhesion of current collector and active material, and attributes such adhesion to the following surface roughness characteristics:

[1] 10-point mean roughness R_z of 1.0 – 5 μm ;

[2] R_a of 0.25-0.7 μm ; and

[3] Both surfaces (matte surface and shiny surface) of electrolytic copper foil exhibiting similar roughness characteristics (e.g., similar R_z and similar R_a).

SOLUS-1004, Abstract, see [0029], [0031], [0032], [0073], [0074].

For instance, Shinozaki discloses example data (e.g., from Working Example 6) of R_z at 2.8 μm , R_a at 0.46 μm , and S_m (or R_{sm}) at 50.00 μm for the shiny surface of an example copper electrolytic foil. SOLUS-1004, Table 3, Work. Ex. 6, [0116]; SOLUS-1003, ¶39.

As explained below, Dr. Randall provides two different approaches, the latter approach being more mathematically precise and rigorous than the former, to [1] confirm that Shinozaki’s example data (e.g., from Working Example 6) exhibit R_{pc} value that falls within the claimed range of “ R_{pc} of 10 to 100” and [2] present

other data of Shinozaki that also exhibit R_{pc} values that fall within the claimed range. SOLUS-1004, Table 3; SOLUS-1003, ¶40.

First, Dr. Randall explains that R_{pc} can be approximated based on the S_m and R_a values disclosed in the example data of Shinozaki. For example, S_m value of the example data (e.g., Working Example 6) of Shinozaki can be converted to R_{pc} value of 40 by using R_a value as proxy for the upper and lower criteria lines of $\pm 0.5 \mu\text{m}$. SOLUS-1003, ¶41.

More specifically, as described above, S_m (e.g., S_m of JIS B0601) can be converted to R_{pc} based on the following equation: $R_{pc} = L / S_m$. SOLUS-1019, 20-21; SOLUS-1018, 14, 21. Here, as the example data in Shinozaki do not specify upper and lower criteria lines, this Working Example 6 in Shinozaki yields $R_{pc} = 4 \text{ mm} / 50.00 \mu\text{m} = 80$ effective peaks, a maximum for Working Example 6. SOLUS-1004, Table 3. However, because the claim requires “upper criteria line of $0.5 \mu\text{m}$ ” and “lower criteria line of $-0.5 \mu\text{m}$,” the R_{pc} value would be lower than maximum value of 80 for Shinozaki’s Working Example 6 as described below. SOLUS-1003, ¶41.

The R_a value of $0.46 \mu\text{m}$ of Shinozaki’s Working Example 6 (which becomes $0.5 \mu\text{m}$ when rounded to the number of significant figures disclosed in [1e] for upper and lower criteria) can then be used toward estimating R_{pc} that satisfies the limitations regarding “upper criteria line of $0.5 \mu\text{m}$ ” and “lower

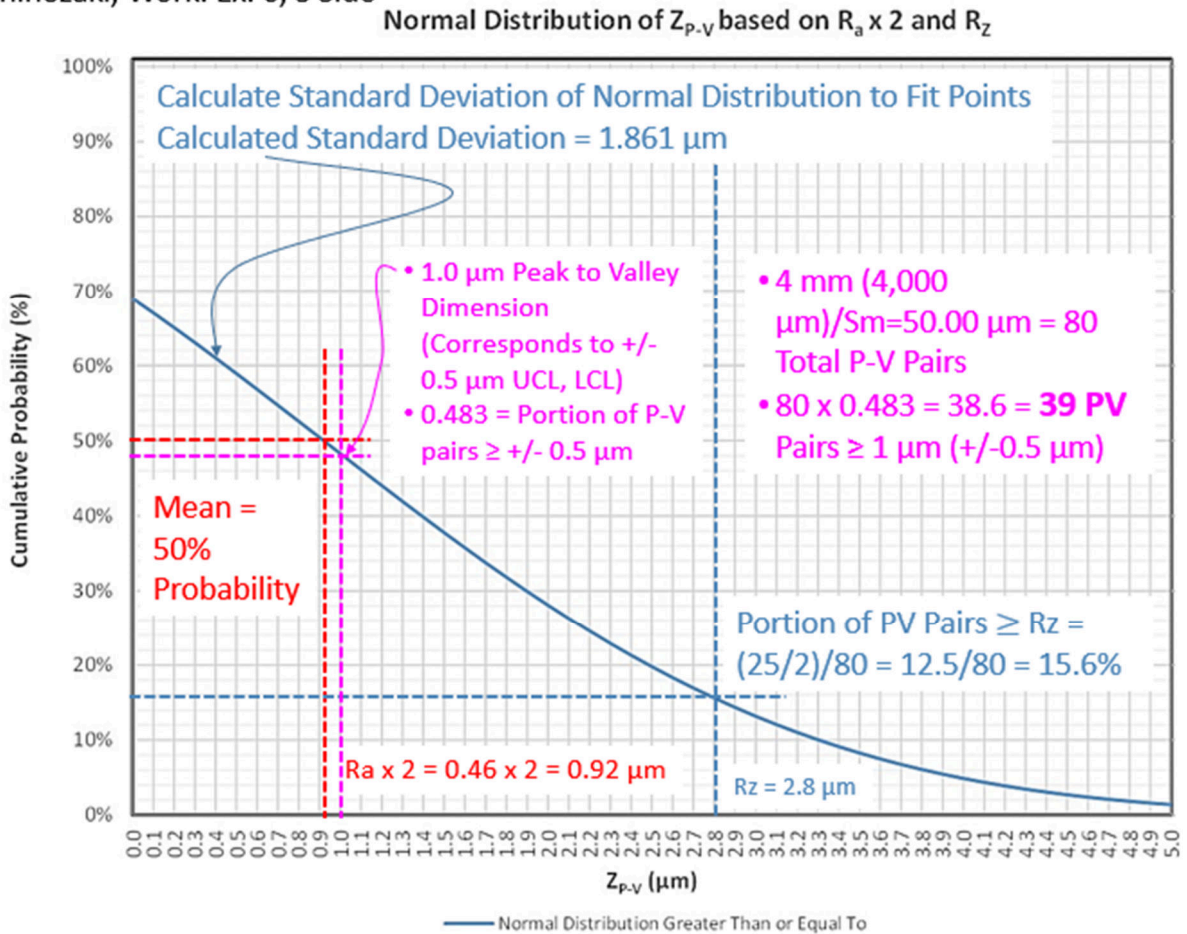
criteria line of $-0.5\ \mu\text{m}$ ” in [1e]. As explained by Dr. Randall, R_a represents the average absolute value of the deviation from the mean line of the surface over a specified sampling length. Therefore, the R_a value ($\approx 0.5\ \mu\text{m}$) can be used as a reliable proxy for the upper ($+0.5\ \mu\text{m}$) and the lower criteria ($-0.5\ \mu\text{m}$) lines in the case of Working Example 6 of Shinozaki. Thus, a POSITA would have known to estimate that approximately half of the peaks and valleys in Shinozaki’s example will rise above and fall below the R_a or upper/lower criteria lines of $\pm 0.5\ \mu\text{m}$. Thus, R_{pc} or the peak count derived above (without considering the upper/lower criteria lines of $\pm 0.5\ \mu\text{m}$) would be halved when considering Working Example 6. For instance, now the calculation would yield $R_{pc} = [4,000\ \mu\text{m} \text{ (or } 4\text{mm}) / (50.00\ \mu\text{m})] \times 1/2 = 40$ effective peaks. SOLUS-1003, ¶42.

Further, Dr. Randall explains that a POSITA would have understood that these 40 effective peaks would not always have peaks and valleys which consecutively exceed (e.g., peak-valley-peak-valley consecutive sequence) these criteria, so the actual R_{pc} is likely to be slightly less than, if not equal to, the R_{pc} estimate of 40 for Working Example 6. Accordingly, a POSITA would have understood that at least the shiny side of Working Example 6 of Shinozaki, for example would have R_{pc} of approximately 40, which falls within the claimed range of “10 to 100.” SOLUS-1003, ¶43.

Second, to help further validate the Rpc determination approaches above, Dr. Randall provides a more mathematically rigorous approach to determine or otherwise confirm that the data disclosed in Shinozaki exhibit Rpc values falling within the claimed range. For instance, “[t]he Gaussian (normal) distribution has become one of the mainstays of surface classification.” SOLUS- 1024, 4. Based on performing Gaussian distribution, Table 3 of Shinozaki has been re-developed, and the Rpc of Working Example 6 is estimated to be 39. SOLUS-1003, ¶44.

To help illustrate, a simple Gaussian (normal) distribution of Table 3 of Shinozaki is shown below. Here, the x-axis represents peak-to-valley pair height (e.g., distance), and the y-axis represents the cumulative probability corresponding to proportion of peak-valley pairs with height greater than or equal to peak-to-valley pair height specified on the x-axis. *Id.*, ¶45.

Shinozaki, Work. Ex. 6, S Side



Id., ¶45.

Dr. Randall explains that this normal distribution has been developed by at least performing the following steps:

[1] Multiplying R_a (average height of surface profile from the centerline) by 2 to calculate average peak-to-valley height of the surface profile, in which the average peak-to-valley height corresponds to the x-axis value (e.g., $0.92 \mu\text{m} = 2 \times 0.46 \mu\text{m}$ (R_a) for Shinozaki's Working Example 6) at y-axis value indicating 50% cumulative probability;

[2] Utilizing Rz value (average peak-to-valley height among the sum of absolute values of the five highest peaks and the absolute values of the five lowest valleys) as x-axis value occupying lower end of the cumulative probability on the y-axis. The corresponding y-axis value is determined by calculating the proportion of half of Rz's 25 peak-valley pairs among the total number of peak-valley pairs. (Rz represents 5 peak-valley pairs over a 0.8 mm reference length, and [1e] specifies a "sampling length of 4 mm," which results in 25 pairs corresponding to Rz). Since Rz is an average value, approximately half of these 25 peak-valley pairs will have a peak-to-valley height greater than Rz, while the other half will have a height less than Rz. Accordingly, 12.5 peak-valley pairs correspond to the proportion of peak-to-valley height data points greater than or equal to Rz, occupying the lowest end of the cumulative probability on the y-axis; and

[3] Using two pairs of data points [1st pair (Ra x 2, 50% cumulative probability) and 2nd pair (Rz, calculated cumulative probability)] to determine the associated standard deviation and to establish the normal distribution. *Id.*, ¶46.

Once the normal distribution is developed, a POSITA would be able to determine the cumulative probability (y-axis value) at the x-axis value of 1.0 μm , in which such cumulative probability represents the proportion of peak-valley pairs

with height that rises above and falls below the upper and lower criteria lines of $\pm 0.5 \mu\text{m}$. Thereafter, Pc or the peak count (derived from Sm without considering the upper/lower criteria lines of $\pm 0.5 \mu\text{m}$) can be multiplied by the cumulative probability to determine Pc (effective peaks, peak-valley pairs) that satisfies the upper and lower criteria lines of $\pm 0.5 \mu\text{m}$. *Id.*, ¶47.

Ultimately, as Dr. Randall goes to explain more in detail in his declaration, a POSITA would have understood that, given the Ra, Rz and Sm values disclosed in Shinozaki (e.g., at Table 3), it would have been straightforward to calculate the number of peaks, and thus the peak count (Rpc) of the copper foils using the appropriate application of normal statistics. *Id.*, ¶¶48-57. As a result, the table below shows calculated Rpc values based on the data in Shinozaki Table 3. *Id.*, ¶57. As shown, the calculated Rpc of Working Example 6 corresponds to 39 and 71 for the S surface and M surface, respectively. Additionally, the calculated Rpc of Working Example 5 corresponds to 64 and 15 for S surface and M surface, respectively, and the calculated Rpc of Working Examples 1 and 3 for M surface corresponds to 87 and 78, respectively. *Id.*, ¶57.

		Calculated Rpc after roughening	
	Untreated Collector	S surface	M surface
Work. Ex. 1	A1	107	87
Work. Ex. 2	A1	141	96
Work. Ex. 3	A1	121	78
Work. Ex. 4	A1	180	110
Comp. Ex. 1	A1	142	189
Comp. Ex. 2	A1	104	40
Work. Ex. 5	A2	64	15
Work. Ex. 6	A3	39	71
Comp. Ex. 3	A3	92	177
Comp. Ex. 4	B1	133	137
Comp. Ex. 5	B1	100	109
Comp. Ex. 6	B1	213	110
Comp. Ex. 7	B2	93	74
Comp. Ex. 8	B3	43	28

Id., ¶57.

Accordingly, Shinozaki’s Rpc values (that satisfy the teachings of Shinozaki) fall within the claimed range of Rpc of “10 to 100.” These specific Rpc values disclosed by Shinozaki are thus a relevant disclosure for the recited range of Rpc values. *See 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”);

Titanium Metals Corp. of Am. v. Banner, 778 F.2d 775, 782 (Fed. Cir. 1985); *In re Petering*, 301 F.2d 676, 682, 49 C.C.P.A. 993, 1001, 133 USPQ 275, 280 (1962)).

Thus, Shinozaki renders obvious the electrolytic copper foil having a surface with R_{pc} of “10 to 100.” SOLUS-1003, ¶58.

Regarding limitation [1d], S_m, which is correlated with and can be used to calculate or derive R_{pc}, is an average value of S_m values measured at multiple randomly selected points, thus rendering this limitation obvious. *See* SOLUS-1017, 16-18. As explained by Dr. Randall, a POSITA would find it obvious and reasonable to make such random measurements over at least three randomly selected points or locations, to reduce sampling bias. Further, the surface roughness manual generally explains that surface roughness parameters are measured according to randomly sampled places. SOLUS-1003, ¶59 (citing SOLUS-1017, 3, 10, 12, 15, 18, 21, 24, 27).

Moreover, because [1] Shinozaki teaches having both surfaces (shiny surface and matte surface) of the electrolytic copper foil exhibiting similar surface characteristics and [2] it was conventional to process both sides to exhibit similar surface roughness characteristics, a POSITA would have applied similar R_{pc} values to both sides of the electrolytic copper foil. SOLUS-1004, [0122], [0073],

[0074]; SOLUS-1008, [0005], [0008]; SOLUS-1009, 1:12-18, 12-22-26; SOLUS-1003, ¶60.

At least for these reasons, Shinozaki renders this claim limitation obvious.
SOLUS-1003, ¶61.

4. Additionally, a POSITA [1] would have recognized that R_{pc} is a recognized, result-effective variable, and [2] would've been motivated to further optimize R_{pc} or otherwise confirm whether R_{pc} in Shinozaki aligns with Shinozaki's teachings of other surface roughness parameter values

At least for the reasons described below, R_{pc} is a recognized, result-effective variable known to be correlated with [1] enhancing surface roughness characteristics and [2] providing void-reduced and uniform copper deposits, which are related to enhancing adhesion properties of the electrolytic copper foil.
SOLUS-1004, [0073], [0074]; SOLUS-1003, ¶62.

First, it was well-known that “[b]y controlling spacing parameters [e.g., roughness parameters such as R_{pc}, R_{sm}, S_m] it is possible to obtain better bounding [e.g., bonding] of finishes, more uniform finish of plating.” SOLUS-1016, 7. For instance, prior art emphasizes that “[o]ne of the spacing parameter is the *peak spacing*, which can be an important factor in the performance of *friction surfaces*.” *Id.*; SOLUS-1003, ¶63 (explaining that “[S]pacing parameters are important in optimizing the performance of surface where friction is important,

enhancing attributes like mechanical grip [e.g., adhesion] between the current collector and the active material of secondary batteries”).

Second, although R_{pc} is categorized as a spacing parameter, its determination based on upper and lower criteria lines establishes a correlation with height (e.g., amplitude) parameters such as R_a (the average height of the surface roughness from the mean line). Specifically, as stated in the claim language [1e], peaks are counted as “effective peaks” only if they satisfy height threshold requirement of “upper criteria line of 0.5 μm ” and “lower criteria line of -0.5 μm .” Therefore, if R_{pc}’s upper/lower criteria lines are set to values such as $\pm 0.5 \mu\text{m}$ that are similar to average height R_a value(s) taught in Shinozaki (e.g., R_a of 0.25-0.7 μm), then R_{pc} becomes correlated with R_a, as they both express height characteristics. SOLUS-1003, ¶64. This indicates that:

[1] By controlling R_{pc} (as a *result-effective variable*) based on its height characteristics (e.g., upper/lower criteria lines), a POSITA can target and obtain certain surface profile characteristics, such as consistency or distribution of peaks that meet the threshold height. This consistency or uniformity of peaks is related to enhancing the surface properties of the electrolytic copper foil, thereby improving the adhesion between the current collector and the active material of the secondary battery; and

[2] The objective of controlling Rpc can also be correlated with the objective of controlling Ra (average surface roughness), one goal of which is to enhance the surface properties of the electrolytic copper foil so as to improve adhesion (and consistency of adhesion) between the foil and the active material of the secondary battery. SOLUS-1003, ¶65 (citing SOLUS-1004, [0044], [0045], [0073], [0074]; SOLUS-1032; SOLUS-1033).

Third, it was demonstrated that Rpc is associated with providing void-reduced, smoother, and more uniform copper deposits, which are the features that are related to enhancing adhesion properties of the copper foil. For example, in prior art (Fabian), in studying the effects of organic additives on the production of void-reduced, smoother, and more uniform copper deposits, PPC (which is a proxy for Rpc per at least DIN EN ISO 4287 as discussed below) was used as one of main parameters to evaluate these effects. SOLUS-1005, Abstract, 8, 11, FIGS. 8, 11. Further, prior art (Fabian) simultaneously discloses [1] copper deposits that can be used for printed circuit board (PCB) and microelectronics, which can be compatible with use in secondary batteries and [2] Rpc values of the copper foil that fall within the claimed Rpc range, describing that such Rpc values are useful values *for enhancing uniformity or void reduction of copper foil surface*, which also aligns with a design objective in Shinozaki. SOLUS-1005, 2, Tables 1, 6; SOLUS-1004, [0073]; SOLUS-1003, ¶65.

Accordingly, as described above by Gadelmawla, Fabian, and Dr. Randall, a POSITA [1] would've recognized that Rpc is a result-effective variable that affects adhesion properties of electrolytic copper foil and [2] would've been motivated to further optimize Rpc or otherwise confirm whether Rpc in Shinozaki's copper foil aligns with Shinozaki's teachings of other surface roughness parameter values.

The rationale is summarized as follows:

[i] Rpc is a known spacing parameter that can be controlled "to obtain better bounding of finishes, more uniform finish of plating";

[ii] it was known that peak spacing (that is correlated to Rpc, as described above) is an "important factor in the performance of friction surfaces," which is relevant to enhancing mechanical grip (adhesion) between the current collector and the active material of secondary batteries;

[iii] it was known that, by controlling Rpc based on Rpc's height characteristics (e.g., upper/lower criteria lines), a POSITA would target to obtain certain surface profile characteristics, such as consistency or distribution of peaks that meet the threshold height requirement and/or other height parameters (e.g., Ra);

[iv] in many instances, the objective of controlling Rpc can also be correlated with the objective of controlling Ra (average surface roughness);

[v] it was demonstrated that Rpc is associated with providing void-reduced, smoother, and more uniform copper deposits; and

[vi] Rpc values⁸, such as 33.1⁹ and 33.3¹⁰ in prior art (Fabian) have been shown to be effective toward enhancing uniformity or void reduction of copper foil surface, which also aligns with the design objectives of Shinozaki (e.g., providing void-reduced surface to enhance adhesion properties). *See* SOLUS-1016, 7; SOLUS-1005, Abstract, 8, 11, FIGS. 8, 11; SOLUS-1004, [0073]; SOLUS-1003, ¶66.

Further, a POSITA would have expected success in optimizing Rpc, at least for the following reasons. SOLUS-1003, ¶67.

⁸ According to the DIN EN ISO 4287 measurement standard, it is recommended to use $\pm 0.5 \mu\text{m}$ as the upper/lower criteria line height threshold. Dr. Randall explains that, unless otherwise specified by Fabian, Fabian should have followed this recommendation and use the $\pm 0.5 \mu\text{m}$ criteria lines. SOLUS-1019, 20-21; SOLUS-1003, ¶66.

⁹ Converted from 82.75 peaks / 1 cm to 33.1 peaks / 4 mm. SOLUS-1005, 8, Table 6; SOLUS-1003, ¶66.

¹⁰ Converted from 83.38 peaks / 1 cm to 33.3 peaks / 4 mm. *Id.*

First, as explained by Dr. Randall and prior art, the optimization of R_{pc} would have involved a mere routine optimization of electrodeposition conditions, such as varying concentrations of additives (e.g., organic additives), electrolysis solution chemistry, which includes copper sulfate and sulfuric acid, treatment time, and/or current density. For instance, as demonstrated in Fabian, simple variation of concentration of organic additives, such as Guar or APAM, affects R_{pc} values. SOLUS-1005, Abstract, 8, FIGS. 8, 11. Further, for instance, it was demonstrated in prior art (Dobashi) that variation of electrolysis solution and/or current densities are factors that contribute to the control of S_m or R_{sm} values, which are directly correlated with R_{pc} values. SOLUS-1007, Table 4 (demonstrating comparison of R_{sm} values between Examples 1-7 and Comparative Example), [0020]-[0022] (disclosing varying of current densities in electrolysis), [0023]-[0028] (disclosing specific compositions and concentrations of electrolytic solutions), [0097] (disclosing experimental conditions for the Comparative Example); SOLUS-1003, ¶67.

Second, as described in the preceding paragraph, prior art (Fabian) along with prior known knowledge, suggests the experimentation needed to achieve the values (e.g., R_{pc} of 33.1 and 33.3 of Fabian) that fall within the claimed range (R_{pc} of 10-100), thereby contributing to the reasonable expectation of success and

the rationale for obviousness. *In re Boesch*, 617 F.2d 272, 276 (C.C.P.A. 1980); SOLUS-1003, ¶68.

Third, as described above, because Rpc's recommended upper and lower criteria threshold are 0.5 μm and -0.5 μm respectively, which fall within the Ra range (0.25-0.7 μm) taught by Shinozaki, the objective of controlling Rpc can also be correlated with the objective of controlling Ra (average surface roughness). For instance, as described above, one objective of controlling Ra in Shinozaki is to enhance adhesion properties of copper foil surface. Similarly, controlling Rpc can achieve the same goal by ensuring consistency or uniformity of peaks that meet the threshold height (e.g., upper and lower criteria lines such as $\pm 0.5 \mu\text{m}$).

Accordingly, as explained by Dr. Randall, a POSITA would have known to control Rpc, either alone or in addition to Ra, to enhance surface uniformity near the threshold height of 0.5 μm and thus reduce voids for example, thereby improving adhesion properties and confirming consistency or distribution of peaks that meet the teachings of Ra in Shinozaki. SOLUS-1003, ¶69.

Fourth, as described above with respect to motivation to optimize Rpc, advantages of optimizing Rpc were well-demonstrated in prior art. For instance, [1] it was known to use Rpc "to obtain better bounding of finishes, more uniform finish of plating," [2] it was known that peak spacing (that is correlated to Rpc, as described above) is an "important factor in the performance of friction surfaces,"

which is relevant to enhancing mechanical grip (adhesion) between the current collector and the active material of secondary batteries, and [3] it was known to use Rpc to enhance uniformity or void reduction of copper foil surface. SOLUS-1003, ¶70.

Therefore, a POSITA [1] would have known that Rpc is a recognized, result-effective variable, and [2] would have been motivated to further optimize Rpc in addition to Shinozaki's teachings of other surface roughness parameter value(s). *See In re Aller*, 220 F.2d 454 (CCPA 1955) ("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"); *see also In re Applied Materials, Inc.*, 692 F.3d 1289, 1297 (Fed. Cir. 2012) ("A recognition in the prior art that a property is affected by the variable is sufficient to find the variable result-effective"); *see also KSR International Co. v. Teleflex Inc.*, 550 U.S. 398 (2007) (holding that "obvious to try" is a valid rationale for an obviousness finding); *see also Pfizer, Inc. v. Apotex, Inc.*, 480 F.3d 1348 (Fed. Cir. 2007) (emphasizing that "obviousness cannot be avoided simply by a showing of some degree of unpredictability in the art so long as there was a reasonable probability of success"); SOLUS-1003, ¶71.

5. Alternatively and/or additionally, it was demonstrated in prior art (Fabian) that [1] Rpc within the claimed range was effective toward surface adhesion characteristics (e.g., uniform surface) and [2] Fabian's electrolytic copper foil can be used toward forming a current collector of secondary batteries

First, as described above, Fabian discloses electrodeposited copper foil surface that can be used for PCB and microelectronics, which is compatible with use in secondary batteries. Such use compatibility of electrodeposited copper foil between the PCB and the secondary batteries were well-known. SOLUS-1011¹¹, [1], [7], [14]-[15], [45]-[46], claims 9, 10; SOLUS-1007, [0107]; SOLUS-1008, [0001], [0005], [0012], [0066]; SOLUS-1003, ¶72.

Second, Fabian discloses Rpc values that fall within the claimed range. As described above, Fabian discloses Rpc values such as 33.1 and 33.3, which fall within the claimed range, and at the same time, these values in Fabian were shown to be effective toward enhancing uniformity or void reduction of copper foil surfaces. Additionally, Fabian discloses Rpc values of 26.0 and 35.0, which were not treated with specific organic additive APAM, but still can be used as electrolytic copper foils for PCB and secondary batteries. SOLUS-1005, 8, Table 6; SOLUS-1003, ¶73.

Third, as described above, because [1] Shinozaki teaches having both surfaces (shiny surface and matte surface) of the electrolytic copper foil exhibiting similar surface characteristics and [2] it was conventional to process both sides to

¹¹ WO2015/102323 to Choi (SOLUS-1010) was published in Korean. Thus, all citations to Choi are to its English translation (SOLUS-1011).

exhibit similar surface roughness characteristics, a POSITA would have targeted similar R_{pc} values to both sides of the electrolytic copper foil in Fabian. SOLUS-1004, [0073]-[0074], [0122]; SOLUS-1008, [0005], [0008]; SOLUS-1009, 4:23-28, 4:57-60, 6:36-37; SOLUS-1003, ¶74.

At least for the reasons described above, Fabian in view of conventional knowledge alternatively and/or additionally renders obvious the limitation of overall claim 1. *See Ineos*, 783 F.3d at 869, *Titanium Metals*, 778 F.2d at 782; SOLUS-1003, ¶75.

(ii) Claim 2

[2]

As described above and illustrated below, Shinozaki discloses R_{pc} of 39 and 71 (e.g., for S and M surfaces of Shinozaki's Working Example 6) and R_{pc} of 64 and 15 (e.g., for S and M surfaces of Working Example 5). SOLUS-1003, ¶76. Here, difference in R_{pc} of S and M surfaces of Shinozaki's Working Example 6 equates to 32 (e.g., $71 - 39 = 32$), and difference in R_{pc} of S and M surfaces of Shinozaki's Working Example 6 equates to 49 (e.g., $64 - 15 = 49$), thereby rendering obvious [2]. SOLUS-1003, ¶76.

		Calculated R _{pc} after roughening	
		S surface	M surface
Work. Ex. 1	A1	107	87
Work. Ex. 2	A1	141	96
Work. Ex. 3	A1	121	78
Work. Ex. 4	A1	180	110
Comp. Ex. 1	A1	142	189
Comp. Ex. 2	A1	104	40
Work. Ex. 5	A2	64	15
Work. Ex. 6	A3	39	71
Comp. Ex. 3	A3	92	177
Comp. Ex. 4	B1	133	137
Comp. Ex. 5	B1	100	109
Comp. Ex. 6	B1	213	110
Comp. Ex. 7	B2	93	74
Comp. Ex. 8	B3	43	28

SOLUS-1003, ¶76.

Further, as described above, because [1] Shinozaki teaches having both surfaces (shiny (S) surface and matte (M) surface) of the electrolytic copper foil exhibiting similar surface characteristics and [2] it was conventional to process both sides to exhibit similar surface roughness characteristics, a POSITA would have been motivated to achieve similar R_{pc} values to both sides of the electrolytic

copper foil in Shinozaki. *See* SOLUS-1004, [0004], [0073], [0074], [0122]; SOLUS-1008, [0005], [0008]; SOLUS-1009, 1:12-18; SOLUS-1003, ¶77.

Because it is preferable that shiny and matte surfaces exhibit similar surface profiles, a difference in peak count roughness R_{pc} between the first and second surfaces would be minimized and would easily be 60 or less (e.g., similar or equal surfaces would yield a number close to 0, which is less than 60). Additionally, Dr. Randall's calculations of Shinozaki Table 3 indicate that at least 10 of the 14 examples in Table 3 of Shinozaki have a difference in peak count of 60 or less. Accordingly, Shinozaki renders obvious this claim limitation. SOLUS-1003, ¶78.

(iii) Claim 3

[3]

As described above, Shinozaki teaches the electrolytic copper foil surface having a 10-point mean roughness R_z (or R_{zJIS}) of 1.0–5 μm and both surfaces exhibiting similar roughness characteristics. SOLUS-1004, Abstract, [0031], [0032], [0073], [0074]; SOLUS-1003, ¶79

Further, as explained in Fabian and confirmed by Dr. Randall, “[a] surface profile can have the same surface roughness with a different number of PPC [R_{pc}].” SOLUS-1005, 7, 8. In other words, a surface profile can have the same R_{pc} value while having a different surface roughness R_z value, unless the R_z value is significantly changed (e.g., to less than 1 μm) so as to affect the number of peaks

that cross the upper and lower criteria lines in determining R_{pc}. SOLUS-1003, ¶80.

Here, Shinozaki's R_z value of 1.0-5 µm overlaps with claimed range of "2 µm or less" and thus renders it obvious. Further, the '090 Patent provides no indication of criticality or unexpected results associated with the claimed range of R_z. Thus, the overlapping range of R_z of 1.0-5 µm presents a *prima facie* showing 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))); SOLUS-1003, ¶81.

(iv) Claim 4

[4]

Regarding "thickness of 3 to 20µm," Shinozaki describes that "[i]n the present invention, the [current] collector is preferably one having a thin thickness .

. . [in which the current collector] is preferably an electrolytic copper foil” and that [t]he thickness of the collector is preferably 8 μm when it is thin, while it is about 20 μm when it is thick.” SOLUS-1004, [0072], [0073]. “This is because, the strength of the foil cannot be maintained when it is less than 8 μm , therefore breakage occurs at the time of expansion/contraction of the active material. Further, when it exceeds 20 μm , the battery characteristics can be satisfied, but the battery itself becomes large and heavy, therefore, preferably, the thickness is up to about 20 μm .” SOLUS-1004, [0073]. SOLUS-1003, ¶¶82-83.

Regarding “tensile strength of 30 to 60 kgf/mm^2 ,” Shinozaki describes that “the copper foil is preferably electrolytic copper foil which has . . . a tensile strength of 300 N/mm^2 or more at ordinary temperature.” SOLUS-1004, [0050]. Accordingly, $300\text{N/mm}^2 \times (0.10197 \text{ kgf/mm}^2 / \text{N/mm}^2) = 30.591\text{kgf/mm}^2$. Moreover, Shinozaki Table 2 lists the tensile strength of untreated copper foil, ranging from **31.6 kgf/mm^2** to **40.8 kgf/mm^2** (converted from a range of 310-400 N/mm^2). SOLUS-1003, ¶¶84-85.

(v) **Claim 7**

[7pre]

To the extent the preamble is deemed limiting, Shinozaki renders obvious this limitation. Shinozaki discloses an electrolytic copper foil for negative

electrode current collectors of lithium-ion secondary batteries. SOLUS-1004, Abstract, [0041]. SOLUS-1003, ¶86.

[7a]

Shinozaki discloses “[t]he electrolytic copper foil for lithium ion secondary battery [that] is used as the [current] collector.” SOLUS-1004, [0002], [0038], [0072]; *see* discussion *supra* claim 1. SOLUS-1003, ¶87.

[7b]

Shinozaki describes that the “active material” layer is disposed (or deposited) on the current collector. SOLUS-1004, [0040], [0029], [0038]; SOLUS-1003, ¶88.

[7c]

As described above, Shinozaki describes that the active material is “comprised of primary particles of silicon, germanium, or tin.” SOLUS-1004, [0038]; SOLUS-1003, ¶89.

(vi) Claim 8

[8]

As described above, Shinozaki describes that the active material is “comprised of primary particles of silicon.” SOLUS-1004, [0038]; SOLUS-1003, ¶90.

(vii) Claim 10

[10pre]

See [1pre]; SOLUS-1003, ¶91.

[10a]

Shinozaki discloses “a negative electrode [anode],” “a positive electrode [cathode],” and a “nonaqueous electrolyte.” SOLUS-1004, [0079]; SOLUS-1003, ¶92.

Moreover, it was conventional that [1] the electrolyte is for providing an environment enabling lithium ions to move between the cathode and the anode and [2] the secondary battery would have a separator for electrically insulating the cathode from the anode. SOLUS-1012, [0006]; SOLUS-1003, ¶93.

[10b]

Shinozaki describes that the “negative electrode” includes a current collector made of electrolytic copper foil, which possesses the surface roughness characteristics as described above with respect to claim 1. SOLUS-1004, [0079], [0075]; *See* claims 1, 7; SOLUS-1003, ¶94.

[10c]

As described above, Shinozaki describes the active material layer disposed on the current collector. SOLUS-1004, [0029], [0038], [0040]; *See* [7b]; SOLUS-1003, ¶95.

B. [GROUND 1B] – CLAIMS 5, 6, 9, and 11 ARE OBVIOUS OVER SHINOZAKI AND TOSHIO (OR KIM)

Overview of Toshio

Toshio describes a current collector for use in secondary batteries. SOLUS-1014¹², Abstract, [0051]; SOLUS-1003, ¶96.

Toshio also describes an electrolytic copper foil having surface(s) that undergo a roughening process. *Id.*, [0054]. Relatedly, Toshio focuses on improving cycle characteristics of secondary battery by at least [1] using a predetermined silicon-based active material and [2] enhancing adhesion between the current collector and the active material. *See id.*, [0010]; [0011]; SOLUS-1003, ¶97.

Toshio further describes that using a protective layer such as a chromate layer, a benzotriazole layer, or a silane coupling treatment layer on the copper foil provides many advantages including heat resistance, rust prevention, and adhesion enhancement. *See id.*, [0074], [0092]-[0093], [0111], [0131], [0141], [0175], [0192], [0199], [0216]; SOLUS-1003, ¶98.

Overview of Kim

¹² KR 2014/012942 to Toshio (SOLUS-1013) was published in Korean. Thus, all citations to Toshio are to its English translation (SOLUS-1014).

Kim describes a current collector for use in secondary batteries. SOLUS-1012, Abstract. Moreover, Kim focuses on [1] preventing wrinkles on surfaces of copper foil for a current collector [2] enhancing adhesion between the current collector and the active material. *Id.*, Title, Abstract, [0010],[0026]; SOLUS-1003, ¶¶99-100.

Kim further describes that using a protective layer including a chromate layer provides advantages including corrosion prevention. *See id.*, [0007], [0024], [0025], [0028]; SOLUS-1003, ¶101.

Reasons for combining Shinozaki with Toshio or Kim

A POSITA would have been motivated to apply Toshio's or Kim's teachings regarding use of a protective layer to the Shinozaki's electrolytic copper foil for a current collector and would have expected success, as described below. SOLUS-1003, ¶102.

First, as described above, both Shinozaki and Toshio or Kim describe the use of electrolytic copper foil for a current collector for a secondary battery. SOLUS-1003, ¶103.

Second, both Shinozaki and Toshio or Kim describe the use of electrolytic copper foil with roughened surfaces. SOLUS-1004, Abstract; SOLUS-1014, [0054]; SOLUS-1012, [0025]; SOLUS-1003, ¶104.

Third, as described above, both Shinozaki and Toshio or Kim share a same goal of enhancing adhesion between the current collector and the active material. SOLUS-1003, ¶105.

Fourth, as described above, Toshio and Kim describe that using a protective layer such as a chromate layer, a benzotriazole layer, or a silane coupling treatment layer on the copper foil provides many advantages including heat resistance, rust prevention, corrosion prevention, and adhesion enhancement. SOLUS-1003, ¶106.

Fifth, as explained by Dr. Randall, applying protective layer such as a chromate layer, a benzotriazole layer, or a silane coupling treatment layer on the copper foil was conventional. SOLUS-1003, ¶107.

At least for the reasons described above, a POSITA would have been motivated to apply Toshio's or Kim's teachings regarding use of a protective layer to the Shinozaki's electrolytic copper foil for a current collector and would have expected success in doing so. SOLUS-1003, ¶108.

(i) Claim 5

[5pre]

To the extent the preamble is deemed limiting, Shinozaki renders obvious this limitation. For instance, Shinozaki describes that "[t]he electrolytic copper foil for lithium ion secondary battery is used as the [current] collector." SOLUS-1004, [0002], [0038], [0072]; SOLUS-1003, ¶109.

[5a]

As described above with respect to discussion of claim 1, Shinozaki describes that “[t]he electrolytic copper foil for lithium ion secondary battery is used as the [current] collector” and focuses on describing surface characteristics of the electrolytic copper foil. SOLUS-1004, [0002], [0038]; *see* discussion *supra* claim 1; SOLUS-1003, ¶110.

[5b]-[5c]

Shinozaki and Toshio (or Kim) combination renders obvious [5b]-[5c].
SOLUS-1003, ¶111.

The '090 Patent describes that the protective layer can be formed when “the electrolytic copper foil” is “subjected to anti-corrosion treatment using chromate, benzotriazole, and/or a silane compound.” *See, e.g.* SOLUS-1001, 5:65-6:11, 6:65-7:3; SOLUS-1003, ¶112.

Similarly, in the Shinozaki and Toshio (or Kim) combination, Toshio or Kim teaches protective layer(s) applied to the electrolytic copper foil surface. For instance, as described above, Toshio teaches using a protective layer such as *a chromate layer, a benzotriazole layer, or a silane coupling treatment layer* on the copper foil and describes advantages including heat resistance, rust prevention, and adhesion enhancement. *See* SOLUS-1014, [0074], [0092]-[0093], [0111], [0131], [0141], [0175], [0192], [0199], [0216]. Further, for instance, as described above,

Kim teaches applying *a protective layer* including a *chromate layer* (e.g., “surface-chromated”) to the electrolytic copper foil surface and describes corresponding advantages including “the prevention of corrosion” . SOLUS-1012, [0007], [0024], [0025], [0028]; SOLUS-1003, ¶113.

(ii) Claim 6

[6]

Shinozaki and Toshio (or Kim) combination renders obvious this limitation. SOLUS-1003, ¶114.

Particularly, as described in Toshio and as conventionally understood by a POSITA, [1] active material is typically formed on both surfaces of the current collector substrate and [2] protective layer(s), such as anti-rust layer or corrosion-proof layer(s) is/are applied in between the copper foil surfaces of the current collector and the active material layer. SOLUS-1014, claims 6, 9, 10, [0023], [0074], [0092]-[0093]; SOLUS-1003, ¶115.

Further, as explained by Dr. Randall, it would’ve been obvious for POSITA to apply the protective layer to both surfaces of the copper foil when a POSITA aims to achieve corrosion protection of the copper foil surface of the current collector, which would obviously be applied between it and the active material of the electrode of a secondary battery. SOLUS-1003, ¶116.

Alternatively/additionally, as described above with respect to overview of Kim section, Kim describes use of a protective layer over copper foil surface at least for purposes of preventing corrosion, and it would have been obvious for a POSITA to apply the protective layer to both surfaces of the copper foil to achieve the same anti-corrosion effect on both surfaces of the copper foil. *See* discussion *supra* section Overview of Kim; SOLUS-1012, [0007], [0024], [0025], [0028]; SOLUS-1003, ¶117.

(iii) Claim 9

[9]

Shinozaki and Toshio (or Kim) combination renders obvious this limitation. SOLUS-1003, ¶118.

As described above with respect to discussion of claims 5 and 6, Toshio (or Kim) describes that [1] active material layer is formed on both surfaces of the current collector substrate and [2] protective layer such as *a chromate layer, a benzotriazole layer, or a silane coupling treatment layer* is applied in between the copper foil surfaces of the current collector and the active material layer. *See* [5], [6]; SOLUS-1012, [0007], [0024], [0025]; SOLUS-1003, ¶¶119-121.

(iv) **Claim 11**

[11]

As described above with respect to discussion of limitations of claim 5 (e.g., [5b]-[5c]), claim 6, and claim 9, Shinozaki and Toshio (or Kim) combination renders obvious this limitation. *See* [5b]-[5c], [6], [9]; SOLUS-1003, ¶122.

C. [GROUND 2A] – CLAIMS 1-4, 7, 8, and 10 ARE OBVIOUS OVER SANO AND GRIESI

Overview of Sano

Sano describes an untreated electrolytic copper foil “with low roughness surface whose surface roughness (Rz) is 2.0 μm or less,” which is applicable to both printed circuit board (PCB) and current collector for electrodes of secondary batteries. SOLUS-1008, Abstract, [0001], [0014], [0066]; SOLUS-1003, ¶123.

Sano also describes the need for an electrolytic copper foil¹³ having [1] low surface roughness, [2] uniformity of such low surface roughness over the surface,

¹³ Dr. Randall explains that “Sano refers to electrolytic copper foil for use as a current collector in the negative electrode. In Sano, the terms “anode” and “cathode” are used in the opposite manner from how they are commonly understood by a POSITA in the U.S., a convention often seen in foreign inventions or applications where naming conventions may differ. However, it would have

and [3] minimal surface profile difference between the two surfaces (shiny surface and matte surface) at the same time. *See* SOLUS-1008, [0005], [0006], [0012], [0013]. Sano also focuses on addressing such need by providing an electrolytic copper foil having [1] Rz value of 2.0 μm or less and [2] surface uniformity with minimized irregularities. *See* SOLUS-1008, Abstract, [0014], [0016]; SOLUS-1003, ¶124.

Sano further describes that it was “within the conventional knowledge” to produce electrolytic copper foils where “the difference in roughness between gloss surface and roughness surface can be made as small as possible,” SOLUS-1008, [0008]; SOLUS-1003, ¶125.

Overview of Griesi

Griesi proposes a method for accurately measuring the geometric properties of the copper foil’s surface such that an estimation can be used to estimate the impact of copper foil surface roughness on conductor loss. SOLUS-1015, Abstract; SOLUS-1003, ¶126.

been obvious to a POSITA that electrolytic copper foil is used as a current collector for the negative electrode in a secondary battery. As such, the “cathode” in Sano would be understood as the negative electrode.” SOLUS-1003, ¶124.

Griesi describes the use of a treated electrolytic copper foil and further explains that production of such treated electrolytic copper foil includes [1] production of untreated electrolytic copper foil and [2] surface-treatment of the untreated electrolytic copper foil. SOLUS-1015, 27, FIG. 2.7 (reproduced below); SOLUS-1003, ¶127.

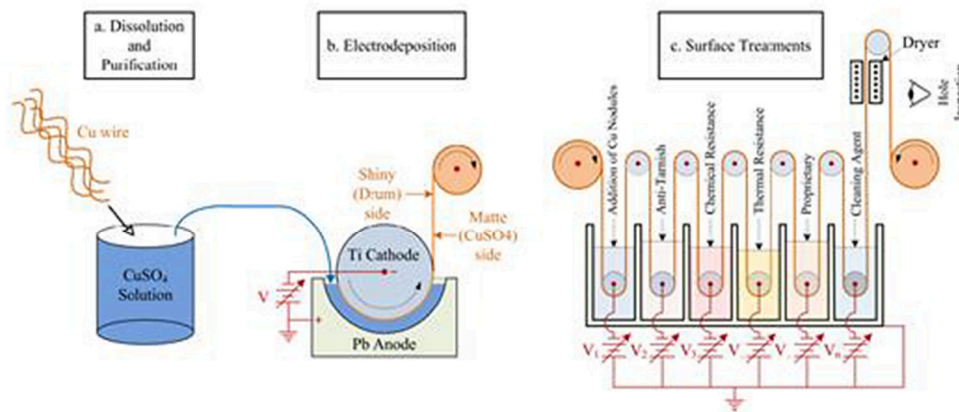


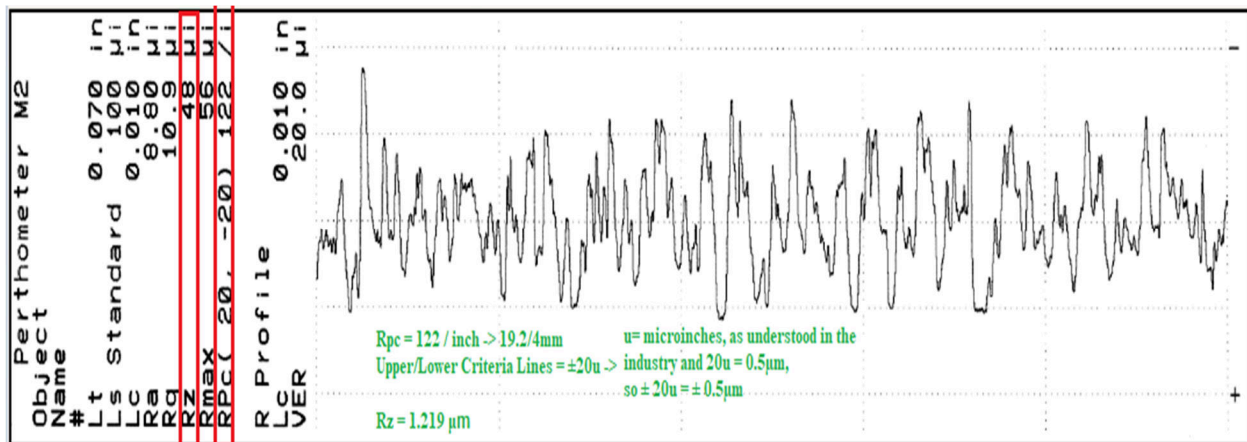
Figure 2.7 Three phases of ED copper foil fabrication. [9]

SOLUS-1015, FIG. 2.7

Griesi explains that it is “necessary to examine the surfaces” of the electrolytic copper foil and further states that “the electrodeposition and surface treatment phases (b and c in Figure 2.7) play key roles in determining the surface roughness of the ED foil.” SOLUS-1015, 27-28; SOLUS-1003, ¶128.

Griesi explains two steps in analyzing the surface: [1] analyzing the *untreated* electrolytic copper foil surface; and [2] analyzing anchor nodules of the *treated* electrolytic copper surface. SOLUS-1015, 31; SOLUS-1003, ¶129.

Regarding surface analysis or characterization of the *untreated* electrolytic copper foil, Griesi describes that one method is to use a “mechanical profilometer (or perthometer) to measure the length, including all of the surface irregularities, in the x and y dimensions to calculate the area.” SOLUS-1015, 51-52. Then Griesi shows an example measurement of the surface of untreated copper foil, as described in below reproduced figure 3.16 of Griesi with annotations. *See* SOLUS-1015, 53-54, FIG. 3.16 or SOLUS-1029, 18-19 (annotated, reproduced below); SOLUS-1003, ¶130.



SOLUS-1015, FIG. 3.16; SOLUS-1029, 18-19

As explained in the above figure 3.16 of Griesi with annotations and confirmed by Dr. Randall, Griesi's untreated electrolytic copper foil surface shows surface roughness parameter values including $R_z = 1.129 \mu\text{m}$ (e.g., $48 \mu\text{in}$) and $R_{pc} = 19.2$ (e.g., 122 peaks per inch = 19.2 peaks per 4 mm sampling length, and

with upper and lower criteria lines of +20 μin , and – 20 μin (+0.5 μm and - 0.5 μm)). SOLUS-1003, ¶131.

Reasons for the combination

As explained by Dr. Randall, Sano explicitly confirms the well-known use of [1] *untreated* electrolytic copper foil and [2] its use compatibility between the PCB and secondary battery collector. Sano teaches producing the *untreated* electrolytic copper foil with surfaces having an $R_z \leq 2 \mu\text{m}$ and surface uniformity with minimized irregularities, which are advantageous and applicable for the PCB or the current collectors of lithium secondary battery. SOLUS-1008, [0001], [0006], [0012], [0013], [0055], [0057], [0059], [0061], [0062], [0066]; *see also* SOLUS-1030, [0025], [0043], [0104], [0107], [0108]; *see also* SOLUS-1031, [0038], [0052]; SOLUS-1003, ¶132.

Similarly, Griesi describes the [1] *untreated* electrolytic copper foil for use in PCB and [2] R_z value that is less than 2 μm . For instance, above reproduced figure 3.16 of Griesi with annotations describe R_z value of 1.2 μm . SOLUS-1015, 53-54. SOLUS-1003, ¶133.

Accordingly, based on the teachings of Sano set forth above, a POSITA looking to further optimize Sano's copper foil surface (which can serve as a starting point) would have considered Griesi's surface roughness profile data (including **R_z** value of 1.2 μm) of the *untreated* electrolytic copper foil and would

have recognized the similarities between Sano and Griesi's copper foil surfaces. A POSITA would have also recognized another surface roughness-related parameter, *R_{pc}*, in Griesi as a potentially useful parameter that can be optimized to further enhance uniformity or generally improve Sano's copper foil surface. SOLUS-1003, ¶134.

In fact, *R_{pc}* was a generally known spacing parameter that could be controlled to obtain better "bounding of finishes" and a "more uniform finish" of the electrolytic copper foil surface. SOLUS-1016, 7; SOLUS-1003, ¶135.

Moreover, prior art indicates that *R_{pc}* was a recognized, result-effective variable known to be correlated with enhancing surface roughness characteristics and providing void-reduced, uniform copper deposits. *See* discussion *supra* Part IV.A.1.(i).[1c]-[1e]; SOLUS-1003, ¶136.

Accordingly, it would have been "normal desire of scientists or artisans to improve upon what is already generally known." *Pfizer, Inc. v. Apotex, Inc.*, 480 F. 3d 1348, 1368 (Fed. Cir. 2007).

Therefore, in the combination, based on disclosure of Sano and Griesi in view of common and prior knowledge, it would have been obvious for a POSITA to optimize *R_{pc}* through routine experimentation to arrive at the claimed range of *R_{pc}*. *See KSR International Co.*, 550 U.S. 398 (2007); SOLUS-1003, ¶137.

Further, a POSITA would have expected success in optimizing the R_{pc} through routine experimentation, at least for the reasons described above with respect to discussion of claim limitation [1c]-[1e] in Ground 1A. *See* discussion *supra* Part IV.A.1.(i).[1c]-[1e]; *Pfizer, Inc.*, 480 F.3d 1348 (Fed. Cir. 2007). For instance, as explained by Dr. Randall and confirmed by prior art, the optimization of R_{pc} would have involved mere routine adjustments of electrolysis conditions, such as varying concentrations of additives, treatment time, and current density. *See id.*; SOLUS-1003, ¶138.

Additionally, prior art and generally known knowledge suggest that achieving values within the claimed range (R_{pc} of 10-100) would be straightforward. The viability and possibility of such values are evidenced at least by Griesi and Fabian (e.g., R_{pc} = 19.2 in Griesi, R_{pc} of 33.1, 33.3 in Fabian). *See* discussion *supra* Part IV.A.1.(i).[1c]-[1e]; *see* SOLUS-1015, FIG. 3.16; SOLUS-1003, ¶139.

1. Analysis

(i) Claim 1

[1pre]

To the extent the preamble is deemed limiting, Sano-Griesi combination renders this preamble obvious.

As described above with respect to the discussion of reasons for the combination, Sano's electrolytic copper foil can be used for the current collector

for electrodes of secondary batteries. SOLUS-1008, [0001], [0066]; *see* discussion *supra* Part IV.C.1; SOLUS-1003, ¶140.

[1a]-[1b]

Sano-Griesi combination renders obvious [1a]-[1b]. For example, in the combination, Sano describes the shiny surface (e.g., “gloss surface”) and the matte surface (e.g., “roughness surface”). SOLUS-1008, [0003]. SOLUS-1003, ¶141.

Further, as explained by Dr. Randall, it would have been obvious for electrolytic untreated copper foil to have both a shiny surface and a matte surface opposite the shiny surface. SOLUS-1003, ¶142.

[1c]-[1e]

At least for the reasons described below, Sano-Griesi combination renders obvious [1c]-[1e]. SOLUS-1003, ¶143.

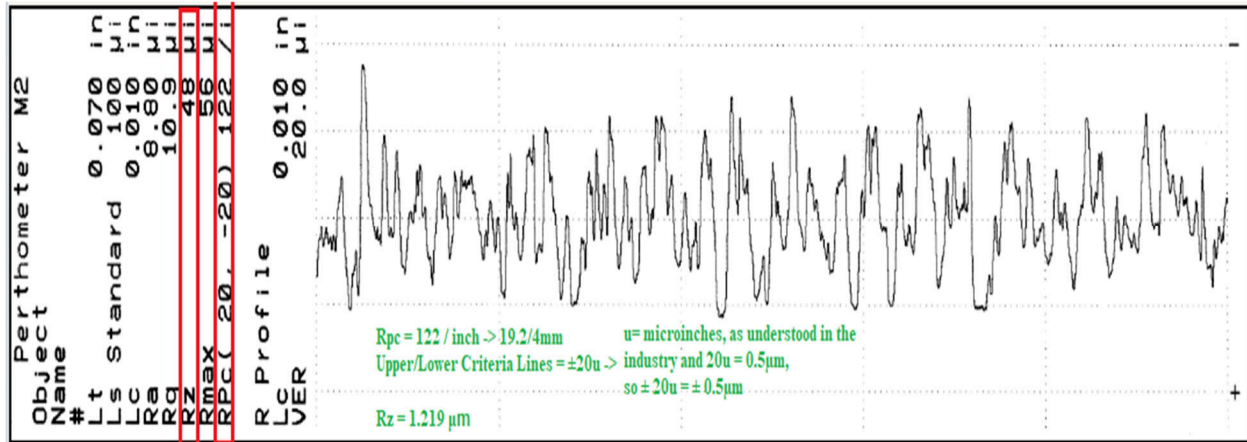
First, as described above with respect to discussion of Ground 1A (Section IV.A.1.), Rpc (peak count roughness) is a recognized measurement shared among different standards. *See* discussion *supra* Part IV.A.1.(i).(1e). SOLUS-1003, ¶144.

Second, in the combination, as described above with respect to discussion of reasons for the combination, based on disclosure of Sano and Griesi in view of common and prior knowledge, it would have been obvious for a POSITA to optimize Rpc of Sano’s electrolytic copper foil surfaces through routine

experimentation to arrive at the claimed range of R_{pc}. *See id.*; *see KSR*

International Co., 550 U.S. 398 (2007). SOLUS-1003, ¶145.

Further, a POSITA would have expected success in optimizing the R_{pc} of Sano's electrolytic copper foil surfaces through routine experimentation, at least for the reasons described above with respect to discussion of claim limitation [1c]-[1e] in Ground 1A. *See discussion supra* Part IV.A.1.(i).[1c]-[1e]; *Pfizer, Inc.*, 480 F.3d 1348 (Fed. Cir. 2007). For instance, as explained by Dr. Randall and as confirmed through various prior art, the optimization of R_{pc} would have involved mere routine adjustments of electrolysis conditions, such as varying concentrations of additives, treatment time, and current density. Additionally, prior art and generally known knowledge suggest that achieving values within the claimed range (R_{pc} of 10-100) would be straightforward, in which the ***viability and possibility of such values are evidenced at least by Griesi and Fabian*** (e.g., R_{pc} = ***19.2*** in Griesi, ***R_{pc} of 33.1, 33.3*** in Fabian). *See discussion supra* Part IV.A.1.(i).[1c]-[1e]; *see* SOLUS-1029, 18-19 or SOLUS-1015, FIG. 3.16 (reproduced below, annotated); SOLUS-1003, ¶146.



SOLUS-1015, FIG. 3.16; SOLUS-1029, 18-19

Alternatively/additionally, this specific Rpm value of 19.2 disclosed in the Griesi is a relevant disclosure for the recited range of Rpm values. *Ineos USA LLC v. Berry Plastics Corp*; SOLUS-1003, ¶147.

Regarding limitation [1d], as described above, a POSITA would find it obvious and reasonable to make such random measurements over at least three randomly selected points or locations, to reduce sampling bias. *see* discussion *supra* Part IV.A.1.(i)[1d]; SOLUS-1003, ¶148.

Third, in the combination, both *shiny and matte surfaces* would have a *peak count roughness Rpm of 10 to 100*. As explained in Sano, “[i]t is within the conventional knowledge that in a process for producing an electrodeposited copper foil . . . the difference in roughness between gloss surface and roughness surface can be made as small as possible.” SOLUS-1008, [0008]. Further, it would have been obvious for a POSITA, aiming to produce electrolytic copper foil for use in either secondary batteries or PCB, to minimize the surface roughness differences

between the two surfaces. This would have ensured a consistent battery reaction and improved circuit accuracy. SOLUS-1008, [0006]; SOLUS-1004, [0004].

Accordingly, a POSITA would have been motivated to produce both surfaces that exhibit similar surface profiles, including roughness characteristics. Therefore, in the combination, both surfaces would exhibit similar R_{pc} values that fall within the claimed range of “10 to 100.” SOLUS-1003, ¶149.

Thus, at least for the reasons set forth above, Sano-Griesi combination renders obvious the electrolytic copper foil having a first surface and a second surface with “ R_{pc} of 10 to 100.” SOLUS-1003, ¶150.

(ii) Claim 2

[2]

As described above, Sano-Griesi combination, in view of common and prior knowledge, renders obvious the limitation that both surfaces of electrolytic copper foil have an “ R_{pc} of 10 to 100.” *See* [1c]-[1e]; SOLUS-1003, ¶151.

Moreover, as described above, [1] Sano-Griesi combination describes the need for having both surfaces (shiny surface and matte surface) of the electrolytic copper foil to exhibit similar surface characteristics, [2] it was conventional to process both sides to exhibit similar surface roughness characteristics, and [3] it was commonly known that similar surface characteristics on both sides of copper foil facilitate bonding between current collector and active material layer, which

directly impact battery performance. *See* SOLUS-1004, [0004], [0073], [0074], [0122]; *see* SOLUS-1008, [0005], [0006], [0008]; *see* SOLUS-1009, 1:12-18; *see* discussion *supra* Part IV.C.1.(i); SOLUS-1003, ¶152.

As such, a POSITA would have been motivated to produce both surfaces to exhibit similar surface profiles, including surface roughness-related characteristics. SOLUS-1003, ¶153.

Because shiny and matte surfaces exhibit similar surface profiles, a difference in peak count roughness R_{pc} between the first and second surfaces would be 60 or less. Therefore, Sano-Griesi renders obvious this claim limitation. SOLUS-1003, ¶154.

(iii) Claim 3

[3]

As described above with respect to the discussion of reasons for the combination section, Sano-Griesi combination describes the electrolytic copper foil surface having $R_z \leq 2 \mu\text{m}$ and both surfaces exhibiting similar roughness characteristics. *See* discussion *supra* Part IV.C.1. Thus, Sano-Griesi renders obvious the electrolytic copper foil having both surfaces with R_{zJIS} of $2 \mu\text{m}$ or

less. *See* [1c]-[1e], [2]; *Ineos*, 783 F.3d at 869, *Titanium Metals*, 778 F.2d at 782; SOLUS-1003, ¶¶155-156.

(iv) Claim 4

[4]

First, regarding the thickness of 3 to 20µm, Sano-Griesi combination renders this limitation obvious. In particular, Sano describes the need for the electrolytic copper foil having “a small thickness” and obtaining the copper foil with the “thickness of 18µm,” which falls within the claimed range. *See Ineos*, 783 F.3d at 869, *Titanium Metals*, 778 F.2d at 782; SOLUS-1008, [0005], [0054], [0062], [0059]; SOLUS-1003, ¶157.

Second, regarding the tensile strength of 30 to 60 kgf/mm², Sano-Griesi combination renders this limitation obvious. In particular, Sano describes a tensile strength range of 350-500 MPa (corresponding to 36.7-51.0 kgf/mm²), shown in the examples that fall within the teachings of Sano. SOLUS-1008, [0055], [0059], [0061], Table 2; SOLUS-1003, ¶158.

Alternatively/additionally, as explained by Dr. Randall and various prior art, it was conventional to produce or obtain electrolytic copper foils that fall within the claimed tensile strength range. SOLUS-1003, ¶159 (citing SOLUS-1004,

[0050], Table 2; SOLUS-1008, Table 2; SOLUS-1009, Table 2; SOLUS-1026¹⁴, claim 5, [0018], [0050], [0051]; SOLUS-1035, 18).

Accordingly, Sano-Griesi in view of common and prior knowledge renders obvious this limitation. SOLUS-1003, ¶160.

(v) Claim 7

[7pre]

See discussion *supra* section [1pre]; SOLUS-1003, ¶161.

[7a]

As described above with respect to the discussion of reasons for the combination, Sano's electrolytic copper foil can be used for current collector for electrodes of the secondary batteries. *See* discussion *supra* Part IV.C; SOLUS-1008, [0001], [0066]; SOLUS-1003, ¶162.

[7b]

Although this limitation is not explicitly disclosed in Sano (or Griesi), this is an inherent and otherwise obvious limitation that would have been known to a POSITA. Indeed, as explained by Dr. Randall, it was common knowledge that such active material or active material layer is essential for functioning of the

¹⁴ JP 2007/217787 to Matsuda (SOLUS-1022) was published in Japanese. Thus, all citations to Matsuda are to its English translation (SOLUS-1026).

secondary battery, for example, for operation of battery's electrochemical reactions during charging and discharging processes. SOLUS-1003, ¶163.

Further, as described above with respect to claim limitation [7b] of Ground 1, prior art (Shinozaki) confirms the prior and common knowledge relating to the active material layer being disposed on the current collector. SOLUS-1004, [0038]; SOLUS-1003, ¶164.

Accordingly, the combination renders obvious this limitation in view of common and prior knowledge. SOLUS-1003, ¶165.

[7c]

As described above with respect to discussion of [7b], it was common knowledge that this active material or active material layer is essential for functioning of the secondary battery, for example, for operation of a battery's electrochemical reactions during charging and discharging processes. SOLUS-1003, ¶166.

Further, it was already disclosed that “silicon, germanium, tin, or an alloyed compound [thereof]” could be used as one or more of active materials. SOLUS-1004, [0038]; SOLUS-1003, ¶167.

Accordingly, the combination renders obvious this limitation in view of common and prior knowledge. SOLUS-1003, ¶168.

(vi) Claim 8

[8]

As described above with respect to discussion of [7c], it was already disclosed that silicon, germanium, tin, or an alloyed compound thereof can be used as one or more of active materials. SOLUS-1004, [0038]; SOLUS-1003, ¶169.

(vii) Claim 10

[10pre]

See discussion *supra* section [1pre]; SOLUS-1003, ¶170.

[10a]

This limitation relates to conventional knowledge. *Id.*, ¶171.

For example, as explained in prior art and further confirmed by Dr. Randall, it was conventional [1] for a battery to have a cathode, an anode, and an electrolyte, [2] that the electrolyte is “for providing an environment enabling lithium ions to move between the cathode and the anode” and [3] the secondary battery would have a separator for electrically insulating the cathode from the anode. SOLUS-1012, [0006]; SOLUS-1003, ¶172.

[10b]

See discussion *supra* claim 1, 7. SOLUS-1003, ¶173.

[10c]

See discussion *supra* [7b]; SOLUS-1003, ¶174.

D. [GROUND 2B] – CLAIMS 5, 6, 9, and 11 ARE OBVIOUS OVER SANO, GRIESI, AND TOSHIO (OR KIM)

Reasons for the combination

As described above, in Sano-Griesi combination, Sano's untreated electrolytic copper foil can be used for a secondary battery current collector. SOLUS-1003, ¶175.

Further, as described above with respect to discussion of reasons for the combination section for Ground 1B, Toshio and Kim describe that using a protective layer such as a chromate layer, a benzotriazole layer, or a silane coupling treatment layer on the copper foil provides many advantages including heat resistance, rust prevention, corrosion prevention, and adhesion enhancement. See discussion *supra* Part IV.B; SOLUS-1003, ¶176.

Accordingly, at least for the reasons described below, it would have been obvious for a POSITA to apply a protective layer to the untreated copper foil of Sano, either with or without surface treatment, with the expectation of success. SOLUS-1003, ¶177.

First, as described above, Toshio and Kim describe advantages of applying a protective layer to the copper foil for use in current collectors. For instance, Toshio describes that using a protective layer such as a chromate layer, a benzotriazole layer, or a silane coupling treatment layer on the copper foil provides many advantages including heat resistance, rust prevention, and adhesion

enhancement. *Id.*; SOLUS-1014, [0074], [0092]-[0093], [0111], [0131], [0141], [0175], [0192], [0199], [0216]. Further, for instance, as described above, Kim further describes that using a protective layer including a chromate layer provides advantages including corrosion prevention. SOLUS-1012, [0007], [0024], [0025], [0028]; SOLUS-1003, ¶178.

Second, Kim describes that such protective layer coating can be applied to the untreated copper foil, either with or without treatment. SOLUS-1012, [0025]; ¶179.

Third, as explained by Dr. Randall, applying one or more layers (e.g., protective layers) including a chromate layer, a benzotriazole layer, an adhesion promoting layer, or a silane coupling treatment layer on the copper foil was conventional. SOLUS-1003, ¶180.

(i) Claim 5

[5pre]

To the extent the preamble is deemed limiting, Sano-Griesi combination renders this preamble obvious. For example, Sano discloses electrolytic copper foil that can be used for current collector for electrodes of the secondary batteries. *See* discussion *supra* Part IV.C; SOLUS-1008, [0001], [0066]; SOLUS-1003, ¶181.

[5a]

See discussion *supra* claim 1. SOLUS-1003, ¶182.

[5b]-[5c]

In the combination (Sano, Griesi, and Toshio or Kim), Toshio or Kim renders obvious [5b]-[5c]; SOLUS-1003, ¶183.

For similar reasons with respect to those discussed above regarding claim 5 in Ground 1B, Toshio or Kim teaches such protective layer that can be applied to the electrolytic copper foil surface. *See* discussion *supra* Part IV. B; SOLUS-1003, ¶184.

(ii) Claim 6

[6]

In the combination, Toshio or Kim renders obvious this limitation. For example, for similar reasons as described above with respect to claim 6 in Ground 1B, Toshio or Kim teaches that the protective layer can be formed on the first and second surfaces of the electrolytic copper foil. *See* discussion *supra* Part IV. B; SOLUS-1003, ¶¶185-186.

(iii) Claim 9

[9]

In the combination, Toshio or Kim renders obvious this limitation. For example, for similar reasons as described above with respect to claim 9 in Ground

1B, Toshio or Kim renders this limitation obvious. *See* discussion *supra* Part IV.

B; SOLUS-1003, ¶¶187-188.

(iv) Claim 11

[11]

In the combination, Toshio or Kim renders obvious this limitation. For example, for similar reasons as described above with respect to claim 11 in Ground 1B, Toshio or Kim renders this limitation obvious. *See* discussion *supra* Part IV.

B; SOLUS-1003, ¶¶189-190.

E. [GROUND 3] – CLAIMS 1-11 ARE OBVIOUS OVER DOBASHI

The sections below provide an introduction to Dobashi.¹⁵

Overview of Dobashi

Dobashi describes an electrolytic copper foil for use in both PCB and secondary batteries. SOLUS-1007, [0001], [0107]; SOLUS-1003, ¶191.

Dobashi describes that an object is “to provide a surface-treated electro-deposited copper foil which has a low profile . . . in which waviness . . . is small,” and that “the present inventors thought out a surface treated electro-deposited copper foil having a bonding surface having a low profile.” SOLUS-1007, Abstract, [0010]; SOLUS-1003, ¶192.

¹⁵ Petitioner incorporates this discussion into Ground 3.

Dobashi further describes that R_{ZJS} adjustment enhances adhesion “when the surface-treated electro-deposited copper foil is bonded to the [] material.”

SOLUS-1007, [0057]; SOLUS-1003, ¶193.

Dobashi particularly attributes the low profile, small waviness, and adhesion enhancement to the following surface roughness characteristics on the deposit side (e.g., *bonding side* for the material):

[1] *The surface roughness (R_{zjs})* (or 10-point mean roughness) of the deposit side being *0.1- 1 μ m*. SOLUS-1007, [0065], Abstract, claim 3;

[2] *PV = 0.05-1.5 μ m*. *Id.*, Abstract, claim 4, [0056] (“The maximum peak to valley height (PV) used as one of indicators for detecting the surface shape in the present invention is the sum of the maximum peak height and maximum valley depth of the sample surface”), [0056] (“The maximum peak to valley height (PV) of the bonding surface of the surface-treated electro-deposited copper foil to be bonded with the [] material is preferably 0.05 μ m to 1.5 μ m”);

[3] *R_{sm} > 0.1 mm*. *Id.*, [0057] (“R_{sm} obtained together with the measurement of R_{zjs} is further preferably more than 0.1”), [0048] (“R_{sm} can also be used as an indicator for judgment of the surface. The surface has small waviness and is smooth when R_{sm} is large, and the surface has large waviness and is rough when R_{sm} is small”); and

[4] *Uniform surface of bonding side*. SOLUS-1007, [0065]; SOLUS-1003, ¶¶194-195.

Dobashi further emphasizes that its electrodeposited copper foil “can also be suitably used as the negative electrode current collector of a lithium-ion secondary battery.” SOLUS-1007, [0107]; SOLUS-1003, ¶196.

1. Analysis

(i) Claim 1

[1pre]

To the extent the preamble is deemed limiting, Dobashi renders this preamble obvious. For example, Dobashi describes that “the surface-treated electro-deposited copper foil according to the present invention can also be suitably used as the negative electrode current collector of a lithium ion secondary battery.” SOLUS-1007, [0107]; SOLUS-1003, ¶197.

[1a]-[1b]

Dobashi renders obvious [1a]-[1b]. For example, Dobashi describes surfaces of “shiny side” and “deposit side.” SOLUS-1007, [0016]-[0018], [0060]-[0066]; SOLUS-1003, ¶198.

[1c]-[1e]

At least for the reasons described below, Dobashi renders obvious [1c]-[1e]. SOLUS-1003, ¶199.

First, as described above with respect to discussion of Ground 1A (Section IV.A.1.), Rpc (peak count roughness) is a recognized measurement shared among different standards. *See* discussion *supra* Part IV.A.1.(i).(1e); SOLUS-1003, ¶200.

Second, as described above, Rpc can be obtained from other surface roughness parameters such as Rsm or Sm. *See* discussion *supra* Part. IV.A.1.Claim 1; SOLUS-1003, ¶201.

Third, Dobashi renders obvious this Rpc limitation, where Dobashi's teachings about surface roughness covers Rpc that fall within the claimed range. In particular, Dobashi's teachings on surface roughness characteristics that improve adhesion properties can be translated into an Rpc value falling within the claimed range. SOLUS-1003, ¶202.

Again, Dobashi's surface profile includes: [1] $Rz_{JIS}^{16} = 0.1\text{-}1.0\text{ }\mu\text{m}$ [2]

$PV^{17} = 0.05\text{-}1.5\text{ }\mu\text{m}$ [3] $Rsm^{18} > 0.1\text{ }\mu\text{m}$. SOLUS-1003, ¶203.

The following Table, along with other two Tables in the Declaration of Dr. Randall, are manually generated hypothetical surface profiles that satisfy Dobashi's teachings of Rz_{JIS} , PV , and Rsm . For instance, these hypotheticals not only [1] align within the teachings of the Dobashi's surface characteristics (e.g., $Rz_{JIS} = 0.1\text{-}1.0\text{ }\mu\text{m}$, $PV = 0.05\text{-}1.5\text{ }\mu\text{m}$, $Rsm > 0.1\text{ mm}$) and [2] but also at the same

¹⁶ Rz represents the average height of the five highest peak-to-lower valley pairs along the sampling length of a surface profile. *See* discussion *supra* Part IV; SOLUS-1003, ¶203.

¹⁷ The maximum peak to valley height (PV) used as one of indicators for detecting the surface shape in the present invention is the sum of the maximum peak height and maximum valley depth of the sample surface. SOLUS-Dobashi, [0056]; SOLUS-1003, ¶203.

¹⁸ Rsm represents the average distance between pairs of consecutive peaks and valleys on a surface, and dividing the sampling length by Rsm gives the number of these peak-valley pairs within that length because it measures how many average-width segments fit into the total length. *See* discussion *supra* Part IV.A.1.(i).[1c]-[1e]); SOLUS-1003, ¶203.

time can be converted to R_{pc} values of 10, 15, and 20, which all fall within the claimed range. Therefore, the hypothetical surface profiles that are generated to satisfy Dobashi's teachings also produce R_{pc} values falling within the claimed range. SOLUS-1003, ¶¶204-207.

	2nd Data Set (See other data sets at SOLUS-1003, ¶¶205, 207) R _z = 1.0 µm, P _V = 1.2 µm, R _{sm} > 0.1 mm, sampling length 0.8mm → R _{pc} ≈ 15 / 4mm				
5 Highest Peaks from mean line	0.6	0.4	0.3	0.6	0.6
5 Deepest Valleys from mean line	-0.6	-0.4	-0.3	-0.6	-0.6
As these are highest peaks and deepest valleys of surface profile, other existing peaks cannot be higher than 0.3 and deeper than -0.3. This indicates that there can't be any more peaks rise above +0.5µm or descend below -0.5 µm about the mean line in this sample (with sampling length of 0.8 mm) **So in these data it is definite that there are 3 effective peaks (R _{pc} = 3) per sampling length of 0.8 mm, and when sampling length is 4mm, R _{pc} =15					

SOLUS-1003, ¶206; *see also id.*, ¶¶205, 207

Therefore, Dobashi renders obvious this R_{pc} limitation, where Dobashi's teachings about surface roughness cover R_{pc} values that fall within the claimed range. *See Ineos USA LLC v. Berry Plastics Corp.*, 783 F.3d 865, 869 (Fed. Cir. 2015); SOLUS-1003, ¶204.

Furthermore, as described above, R_{pc} was a recognized, result-effective variable known to be correlated with enhancing surface roughness characteristics and providing void-reduced, uniform copper deposits. A POSITA would have been motivated to optimize R_{pc} to obtain "electro-deposited copper foil having a good surface condition," which, as taught in Dobashi, requires the bonding surface of the copper foil to be "uniform." SOLUS-1007, [0065]. Moreover, as described

above, such optimization would have involved routine experimentation, and a POSITA would have expected success. *See* discussion *supra* Part IV.A.1.(i).[1c]-[1e]; *see also* discussion *supra* Part IV.C. Therefore, it would have been obvious for a POSITA to optimize Rpc to arrive at the claimed range of Rpc. *See KSR International Co.*, 550 U.S. 398 (2007); SOLUS-1003, ¶¶208-209.

Further, as described above, Dobashi's teachings on surface roughness characteristics pertain to the "bonding surface of the surface-treated electro-deposited copper foil." Accordingly, a POSITA would have understood that when Dobashi's electrolytic copper foil is used as a current collector for the negative electrode in batteries, these teachings would apply to both sides of the foil. This is because, typically both sides of the electrolytic copper foil are bonding sides that adhere to the active material layer, directly impacting the battery's performance. SOLUS-1003, ¶¶210-211.

(ii) Claim 2

[2]

At least for the reasons described below, Dobashi in view of well-known knowledge in the field of secondary batteries renders this claim limitation obvious. SOLUS-1003, ¶212.

As explained by Dr. Randall and evidenced by numerous prior art, a POSITA would have been aware of making both surfaces (e.g., from the matte side

and the shiny side) to exhibit similar surface characteristics to thereby facilitate bonding between current collector and active material layer. *See* SOLUS-1004, [0004], [0073], [0074], [0122]; *see* SOLUS-1008, [0005], [0008]; *see* SOLUS-1009, 1:12-18. SOLUS-1003, ¶213.

Further, as described above, Dobashi's teachings on surface roughness characteristics pertain to the "bonding surface of the surface-treated electro-deposited copper foil." Accordingly, a POSITA would have understood that when Dobashi's electrolytic copper foil is used as a current collector for the negative electrode in batteries, these teachings would apply to both sides of the foil. This is because, typically both sides adhere to the active material layer, directly impacting the battery's performance. SOLUS-1003, ¶214.

Accordingly, because shiny and matte surfaces exhibit similar surface profiles, and because Dobashi teaches criteria (*e.g.*, $R_{sm} > 0.1$ mm) that limit the maximum peak count to 40 or less per 4 mm sampling length, a difference in peak count roughness R_{pc} between the first and second surfaces would necessarily be 60 or less. Therefore, Dobashi in view of common and prior knowledge renders obvious this limitation. SOLUS-1003, ¶215.

(iii) Claim 3

[3]

As described above with respect to the overview of Dobashi, Dobashi teaches Rzjis of the bonding side being 0.1- 1 μ m. SOLUS-1007, [0065], Abstract, claim 3. SOLUS-1003, ¶216.

Because shiny and matte surfaces would exhibit similar surface profiles, as described above with respect to claims 1 and 2, Dobashi renders obvious this limitation. SOLUS-1003, ¶217.

(iv) Claim 4

[4]

Dobashi provides guidance for producing electrolytic copper foils that have thickness less than 20 μ m and discloses examples of electrolytic copper foils having thickness of 12 and 15 μ m. SOLUS-1007, [0062], Table 2. Thus, Dobashi renders obvious this limitation. SOLUS-1003, ¶218.

Alternatively/additionally, as explained by Dr. Randall and various prior art, it was conventional to produce or obtain electrolytic copper foils that fall within the claimed tensile strength range. SOLUS-1003, ¶219 (citing SOLUS-1004, [0050], Table 2; SOLUS-1008, Table 2; SOLUS-1009, Table 2; SOLUS-1026, claim 5, [0018], [0050], [0051]; SOLUS-1035, 18).

Accordingly, Dobashi in view of common and prior knowledge renders obvious this limitation. SOLUS-1003, ¶220.

(v) **Claim 5**

[5pre]

Dobashi describes that “the surface-treated electro-deposited copper foil according to the present invention can also be suitably used as the negative electrode current collector of a lithium ion secondary battery.” SOLUS-1007, [0107]. SOLUS-1003, ¶221.

[5a]

See discussion *supra* claim 1. SOLUS-1003, ¶222.

[5b]-[5c]

Dobashi renders obvious [5b]-[5c]. For example, Dobashi describes “a surface-treated electro-deposited copper foil according to the present invention is a surface-treated electro-deposited copper foil in which any one or more of *rust-proofing treatment* and/or *silane coupling agent treatment are performed on the surface of an electro-deposited copper foil.*” SOLUS-1007, [0011]. SOLUS-1003, ¶¶223-226.

(vi) Claim 6

[6]

Dobashi in view of common and prior knowledge renders obvious this limitation. SOLUS-1003, ¶227.

First, as described above with respect to discussion of claim 5, Dobashi describes applying protective layer to the surface of the electrolytic copper foil. SOLUS-1003, ¶228.

Second, for similar reasons with respect to those discussed above regarding claim 6 in Ground 1B, prior art teaches that [1] active material can be formed on both surfaces of the current collector substrate and [2] protective layer such as anti-rust layer or corrosion-proof layer can be applied in between the copper foil surfaces of the current collector and the active material layer. *See discussion supra* Part IV. B; SOLUS-1003, ¶229.

Further, as explained by Dr. Randall, it would've been obvious for POSITA to apply the protective layer to both surfaces of the copper foil when aiming to achieve a rust-proof effect between the copper foil surface of the current collector and the active material for electrodes of secondary batteries. SOLUS-1003, ¶230.

(vii) Claim 7

[7pre]

To the extent the preamble is deemed limiting, Dobashi renders obvious this limitation at least for the reasons described above with respect to discussion of preamble of claim 1. *See* discussion *supra* section [1pre]; SOLUS-1003, ¶231.

[7a]

Dobashi describes that “the surface-treated electro-deposited copper foil according to the present invention can also be suitably used as the negative electrode current collector of a lithium ion secondary battery.” SOLUS-1007, [0107]; SOLUS-1003, ¶232

[7b]

This is an inherent feature that would have been well-known by a POSITA. As explained by Dr. Randall, it was common knowledge that the active material or active material layer is disposed on the current collector. SOLUS-1003, ¶233.

Further, as described above with respect to claim limitation [7b] of Ground 1, prior art (Shinozaki) confirms this prior knowledge relating to the active material layer being disposed on the current collector. SOLUS-1004, [0038]; *see generally id.*, [0003]-[0026]; SOLUS-1003, ¶234.

Accordingly, Dobashi in view of common and prior knowledge renders obvious this limitation. SOLUS-1003, ¶235.

[7c]

As described above with respect to discussion of [7b], it was common knowledge that this active material (or layer) is essential for functioning of the secondary battery, and it was generally disclosed that silicon, germanium, tin, or an alloyed compound thereof could be used as one or more of active materials.

SOLUS-1003, ¶¶236-237.

Accordingly, the Dobashi in view of common and prior knowledge renders obvious this limitation. SOLUS-1003, ¶238.

(viii) Claim 8

[8]

As described above with respect to discussion of [7c], it was generally disclosed that silicon can be used as an active material layer. SOLUS-1004, [0038]; SOLUS-1003, ¶239.

(ix) Claim 9

[9]

Dobashi in view of common and prior knowledge renders obvious this limitation. SOLUS-1003, ¶240

First, as described above with respect to discussion of claim 5, Dobashi describes applying protective layer to the surface of the electrolytic copper foil. SOLUS-1003, ¶241.

Second, for similar reasons with respect to those discussed above regarding claim 6 in Ground 1B, a POSITA would have found obvious that [1] active material can be formed on both surfaces of the current collector substrate and [2] protective layer such as anti-rust layer or corrosion-proof layer can be applied in between the copper foil surfaces of the current collector and the active material layer. *See* discussion *supra* Part IV.B; SOLUS-1003, ¶¶242-243.

(x) Claim 10

[10pre]

See discussion *supra* claims 1, 7; SOLUS-1003, ¶244.

[10a]

See discussion *supra* IV.C.(vii).[10a]; ¶¶245-246.

[10b]

See discussion *supra* claim 1, 7; SOLUS-1003, ¶247.

[10c]

See discussion *supra* [7b]; ; SOLUS-1003, ¶248.

(xi) Claim 11

[11]

See discussion *supra* claims 5, 6, 9; SOLUS-1003, ¶249.

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-1038. 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-1039.

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 '090 Patent.

VII. CONCLUSION

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

VIII. 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 '090 Patent. The '090 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 at IPR57533-0001IP1@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 13,950 words, which is less than the 14,000 allowed under 37 CFR § 42.24.

Dated: September 20, 2024

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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 by USPS Priority Mail, to the Patent Owner by serving the correspondence address of record as follows:

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