Trials@uspto.gov
571-272-7822

Paper 14
Date: April 23, 2025

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

SOLUS ADVANCED MATERIALS CO., LTD.,
Petitioner,

v.

SK NEXILIS CO., LTD.,
Patent Owner.

IPR2024-01461
Patent 10,811,689 B2

Before JOHN G. NEW, JO-ANNE M. KOKOSKI, and
JON B. TORNQUIST, *Administrative Patent Judges.*

KOKOSKI, *Administrative Patent Judge*.

DECISION
Denying Institution of *Inter Partes* Review
35 U.S.C. § 314

I. INTRODUCTION

Solus Advanced Materials Co., Ltd. ("Petitioner") filed a Petition to institute an *inter partes* review of claims 1–10 ("the challenged claims") of U.S. Patent No. 10,811,689 B2 ("the '689 patent," Ex. 1001). Paper 2 ("Pet."). SK nexilis Co., Ltd. ("Patent Owner") filed a Preliminary Response. Paper 8 ("Prelim. Resp."). With Board authorization, Petitioner filed a Preliminary Reply (Paper 9, "Prelim. Reply"), and Patent Owner filed a Preliminary Sur-reply (Paper 10, Prelim. Sur-reply). We also authorized one-page briefs from each party addressing the recent Director Review decision in *Motorola Solutions, Inc. v. Stellar, LLC*, IPR2024-01205, Paper 19 (PTAB March 28, 2025) ("Motorola"). Paper 12 ("Patent Owner's Supplemental Brief" or "Sup. Brief"); Paper 13 ("Petitioner's Response Brief").

Institution of an *inter partes* review is authorized by statute when "the information presented in the petition . . . and any response . . . shows that there is a reasonable likelihood that the petitioner would prevail with respect to at least 1 of the claims challenged in the petition." 35 U.S.C. § 314 (2018); *see also* 37 C.F.R. § 42.4 (2023). For the reasons discussed below, we deny the Petition and do not institute an *inter partes* review.

A. Real Parties in Interest

Petitioner identifies itself, Volta Energy Solutions Canada Inc., Volta Energy Solutions Europe KFT, Volta Energy Solutions Hungary KFT, and Volta Energy Solutions S.A.R.L. as the real parties in interest. Pet. 77. Patent Owner identifies itself as the real party in interest. Paper 4 (Mandatory Notice), 2.

B. Related Matters

The parties identify the following proceedings as related matters:

- *SK nexilis Co., Ltd. v. Solus Advanced Materials, Co., Ltd.*, No. 2:23-cv-00539 (E.D. Tex.).
- *Solus Advanced Materials Co., Ltd. v. SK nexilis Co., Ltd.*, IPR2024-01460.
- *Solus Advanced Materials Co., Ltd. v. SK nexilis Co., Ltd.*, IPR2024-01462.
- *Solus Advanced Materials Co., Ltd. v. SK nexilis Co., Ltd.*, IPR2024-01463.
- *Solus Advanced Materials Co., Ltd. v. SK nexilis Co., Ltd.*, IPR2025-00005.

Pet. 77; Paper 4, 2.

C. The ’689 Patent

The ’689 patent is directed to “easily handleable electrolytic copper foil, an electrode including the same, a secondary battery including the same, and a method of manufacturing the same.” Ex. 1001, 1:19–22. The ’689 patent teaches that “an electrolytic copper foil having a thickness of 10 μm or less, which is generally used for manufacturing an anode of a lithium secondary battery, is particularly vulnerable to curling or wrinkling,” which “makes handling of the electrolytic copper foil difficult but also makes it impossible to coat the electrolytic copper foil with an active material.” *Id.* at 1:63–2:3. The ’689 patent, therefore, seeks to provide “an electrolytic copper foil having improved handleability and capable of securing a secondary battery having a high durability.” *Id.* at 2:12–14.

Figure 1 is reproduced below.

FIG. 1

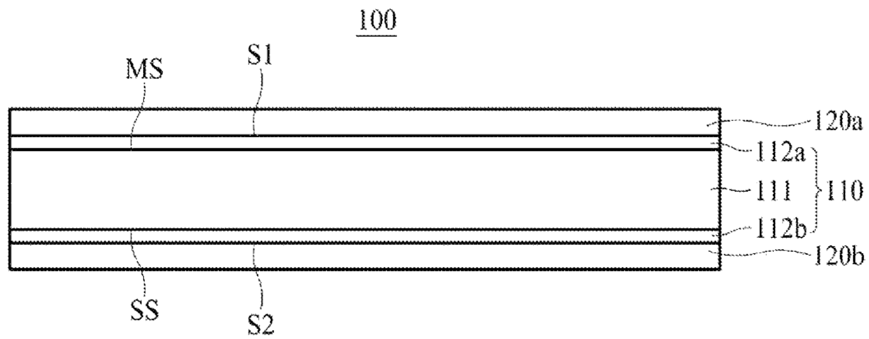


Figure 1 is a cross-sectional view of a secondary battery electrode according to an embodiment described in the ’689 patent. Ex. 1001, 4:13–15. Secondary battery electrode 100 includes electrolytic copper foil 110 with first surface S1 and second surface S2 opposite first surface S1, first active material 120a on first surface S1, and second active material 120b on second surface S2. *Id.* at 4:43–48. Electrolytic copper foil 110 further includes copper layer 111 with matte surface MS facing first surface S1 and shiny surface SS facing second surface S2. *Id.* at 5:8–12. First protective layer 112a is on matte surface MS, and second protective layer 112b is on shiny surface SS. *Id.* at 5:4–7. The first and second protective layers 112a and 112b may include at least one of chromium, a silane compound, and a nitrogen compound, and are “formed to prevent corrosion of the copper layer 111, improve heat resistance of the copper layer 111, and suppress the reduction of a charge and discharge efficiency of the secondary battery by increasing an adhesion strength between the copper layer 111 and the active material layers 120a and 120b.” *Id.* at 5:26–33.

The ’689 patent teaches that the electrolytic copper foil has improved handleability and is capable of securing a secondary battery with high durability when it has a coefficient of thermal expansion (CTE) that ranges from 16 to 22 μm/(m·°C.) when measured with a thermomechanical analyzer (TMA), a tensile strength that ranges from 21 to 36 kgf/mm^2 after being heat treated at 190° C. for 1 hour, a weight deviation that is less than 5%, an elongation of 3% or more at room temperature, a peak count (Pc) of the first and second surfaces that ranges from 3 to 92, and each of the first and second surfaces has a surface roughness (R_z) of 3.5 μm or less. Ex. 1001, 2:12–52. With regard to Pc, the ’689 patent teaches:

> In the present invention, the “peak count (Pc)” may be obtained by measuring peak counts (Pc) of any three points on the surface of the electrolytic copper foil 110 and calculating an average value of measured values of the peak counts (Pc). The peak count (Pc) of each of the points is the number of effective peaks P1, P2, P3, and P4 which rise above a 0.5 μm upper criteria line C1 per 4 mm unit sample length in a surface roughness profile obtained according to U.S. standard ASME B46.1-2009. In this case, at least one valley deeper than a -0.5 μm lower criteria line C2 exists between adjacent effective peaks among the effective peaks. When there is no valley deeper than the -0.5 μm lower criteria line C2 between adjacent peaks which rise above the upper criterial line C1, all of the adjacent peaks may not be “effective peaks” used for measuring the peak count (Pc), and relatively lower peaks among the peaks are ignored when obtaining the number of “effective peaks.”

Id. at 7:43–59.

D. Illustrative Claim

Petitioner challenges claims 1–10 of the ’689 patent. Claims 1, 6, and 10 are independent; claim 1 is illustrative of the claimed subject matter, and is reproduced below.

> 1. [1pre] An electrolytic copper foil, which includes a first surface and a second surface opposite the first surface, the electrolytic coil comprising:

[1a] a copper layer including a matte surface facing the first surface and a shiny surface facing the second surface;

[1b] a first protective layer on the matte surface of the copper layer; and

[1c] a second protective layer on the shiny surface of the copper layer;

wherein:

[1d] a coefficient of thermal expansion of the electrolytic copper foil, which is measured using a thermomechanical analyzer (TMA) while heating the electrolytic copper foil from 30° C. to 190° C. at a speed of 5° C./min, ranges from 16 to 22 μm/(m·° C.),

[1e] a tensile strength of the electrolytic copper foil, which is measured after a heat treatment at a temperature of 190° C. for 1 hour, ranges from 21 to 36 kgf/mm^2,

[1f] a weight deviation of the electrolytic copper foil is 5% or less,

[1g] a peak count (Pc) of each of the first and second surfaces of the electrolytic copper foil ranges from 3 to 92, and

[1h] each of the first and second surfaces has a surface roughness (R_z) of 3.5 μm or less.

Ex. 1001, 13:42–65 (bracketed material added by Petitioner (*see* Pet. vi)).

E. Asserted Grounds

Petitioner asserts that claims 1–10 would have been unpatentable on the following grounds:

Claim(s) Challenged	35 U.S.C. §	Reference(s)/Basis
1–10	103	Shinozaki,[1] Khatibi,[2] Toshio,[3] Kim[4]
1–10	103	Kim, Khatibi, Griesi[5]

Pet. 1. Petitioner relies on the Declaration of Dr. Michael Randall (Ex. 1003) in support of its contentions.

F. Overview of Relevant Surface Measurements

The ’689 patent and the prior art of record disclose various surface measurements, including Rz, Ra, Pc, and Rsm (or Sm). The method of determining Pc described in the ’689 patent is discussed above (§ I.C). We provide an overview of the Rz, Ra, and Rsm (or Sm) measurement methods below.

1. Rz

Rz is a 10-point mean roughness that “represents the sum of the absolute values of the five highest peaks and the absolute values of the five lowest valleys of a surface (e.g., copper foil surface) over a reference

[1] US 2013/0108922 A1, published May 2, 2013 (Ex. 1004, “Shinozaki”).
[2] G. Khatibi, *Temperature Dependent Elastic and Thermal Properties of Thin Copper Foils*, Copper; Proceedings of the International Conference Copper ’06 (2006) (Ex. 1006, “Khatibi”).
[3] Korean Patent Pub. No. 10-2012-0003485, published Jan. 10, 2012 (Ex. 1013; Ex. 1014 (English translation), “Toshio”).
[4] US 2013/0108887 A1, published May 2, 2013 (Ex. 1012, “Kim”).
[5] Griesi, M.B., *Characterization of Electrodeposited Copper Foil Surface Roughness for Accurate Conductor Power Loss Modeling* (2014) (Master’s Thesis, University of South Carolina) (Ex. 1015, “Griesi”).

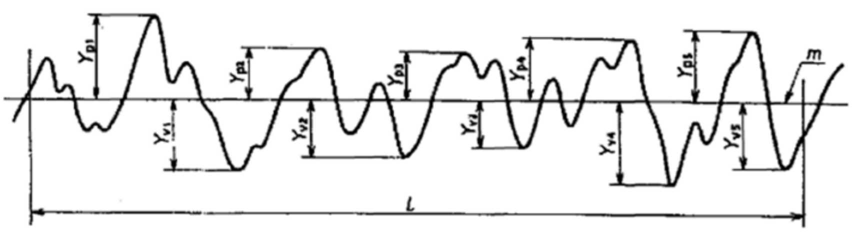
length (l), divided by 5." Ex. 1003 ¶ 15 (citing Ex. 1017, 13–14, Fig. 4; Ex. 1018, 24–25). The method of calculating Rz is reproduced below:

$$R_z = \frac{|Y_{p1} + Y_{p2} + Y_{p3} + Y_{p4} + Y_{p5}| + |Y_{v1} + Y_{v2} + Y_{v3} + Y_{v4} + Y_{v5}|}{5}$$

where, $Y_{p1}, Y_{p2}, Y_{p3}, Y_{p4}, Y_{p5}$: altitudes of the heights of five highest profile peaks of the sampled portion corresponding to the reference length l

$Y_{v1}, Y_{v2}, Y_{v3}, Y_{v4}, Y_{v5}$: altitudes of the depths of five deepest profile valleys of the sampled portion corresponding to the reference length l

Fig. 4. Determination of R_z



Id. (citing Ex. 1017, 13, Fig. 14). As shown above, in determining the Rz value for a reference length l, the absolute value of the five highest peaks Y_{p1}–Y_{p5} and the absolute value for the five lowest valleys Y_{v1}–Y_{v5} are added together, and then the sum is divided by 5. Ex. 1017, 13, Fig. 4. According to at least one standard, when the Rz value is between 0.5 and 10.0 µm, the standard reference length used is 0.8 mm and the evaluation length is 4 mm. Ex. 1003 ¶ 16 (citing Ex. 1017, Table 5).

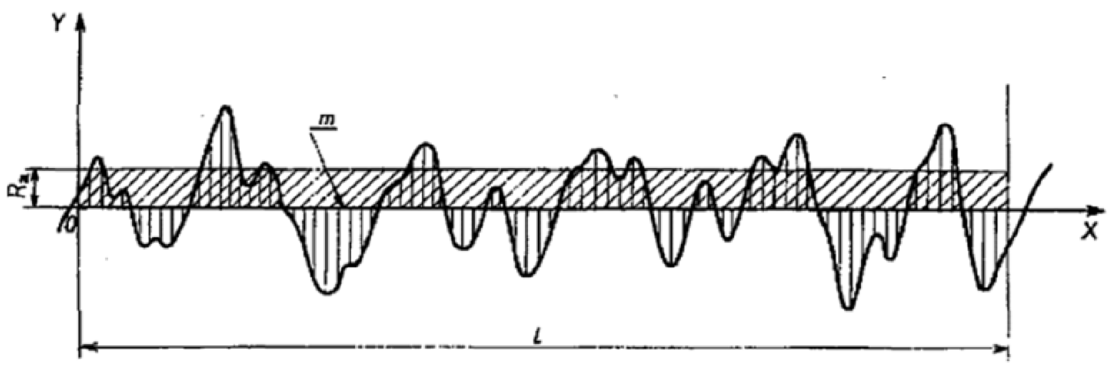
2. Ra

Ra "measures vertical characteristics of the copper foil surface," and "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." Ex. 1003 ¶ 17 (citing Ex. 1016, 1–2; Ex. 1017, 7). According to Dr. Randall, "mathematically, Ra is calculated by integrating the absolute value of the height of the assessed profile 'f(x)' over a reference length (l) and dividing by the reference length." *Id.* (citing Ex. 1017, 7, Fig. 2). The method of calculating Ra is depicted in Figure 2 of Exhibit 1017,[6] reproduced below.

$$R_a = \frac{1}{l}\int_0^l |f(x)|dx$$

where, l **: reference length**

Fig. 2. Determination of R_a



Ex. 1017, Fig. 2. Figure 2 above depicts the integration of the absolute value of the height of profile "f(x)" over reference length l. *Id.*

3. Rsm or Sm

Rsm represents the "mean value of the profile element widths Xs," as shown in the figure below. Ex. 1003 ¶ 76.

[6] Japanese Industrial Standard, *Surface roughness – Definitions and designation,* JIS B 0601 (Ex. 1017).

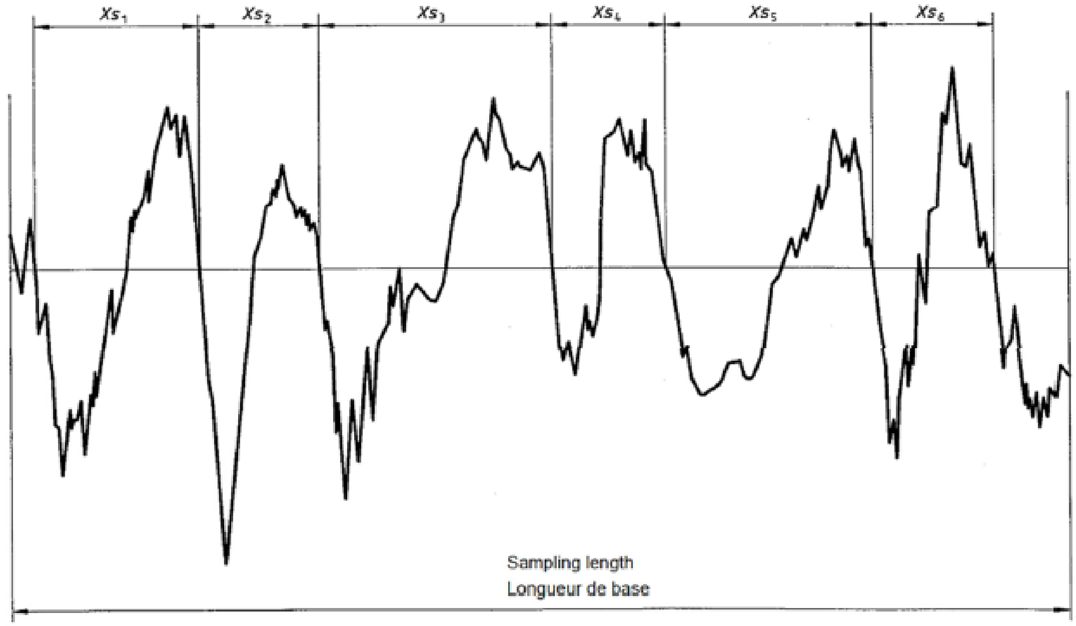


Figure 10 — Width of profile elements
Figure 10 — Largeur des éléments du profil

Ex. 1019, 20–21, Fig. 10.[7] As depicted above, Dr. Randall testifies that "Rsm represents the average distance between pairs of consecutive peaks and valleys." Ex. 1003 ¶ 77. Dr. Randall testifies that "Rsm is also known as Sm." *Id.* ¶ 79.

II. ANALYSIS

A. Level of Ordinary Skill in the Art

Petitioner contends that a person of ordinary skill in the art ("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." Pet. 4. Petitioner further contends that "[a]dditional education, such as a graduate degree, could compensate for less

[7] We refer to the page numbers added by Petitioner to the bottom-center of the page.

work experience, and additional work experience could compensate for less formal education." *Id.* (citing Ex. 1003 ¶ 10). Patent Owner states that, "[f]or purposes of this Preliminary Response, Patent Owner applies Petitioner's level of skill for a person of ordinary skill in the art." Prelim. Resp. 4.

For purposes of this Decision, we adopt Petitioner's undisputed proposed definition because it appears to be consistent with the cited prior art and the disclosure of the '689 patent. *See Okajima v. Bourdeau*, 261 F.3d 1350, 1355 (Fed. Cir. 2001) (explaining that specific findings regarding ordinary skill level are not required "where the prior art itself reflects an appropriate level and a need for testimony is not shown" (quoting *Litton Indus. Prods., Inc. v. Solid State Sys. Corp.*, 755 F.2d 158, 163–64 (Fed. Cir. 1985))).

B. Claim Construction

We construe each claim "in accordance with the ordinary and customary meaning of such claim as understood by one of ordinary skill in the art and the prosecution history pertaining to the patent." 37 C.F.R. § 42.100(b). Under this standard, claim terms are generally given their plain and ordinary meaning as would have been understood by a person of ordinary skill in the art at the time of the invention and in the context of the entire patent disclosure. *Phillips v. AWH Corp.*, 415 F.3d 1303, 1313 (Fed. Cir. 2005) (en banc). Only those terms in controversy need to be construed, and only to the extent necessary to resolve the controversy. *Realtime Data, LLC v. Iancu*, 912 F.3d 1368, 1375 (Fed. Cir. 2019).

Petitioner contends that "no formal claim constructions are necessary in this proceeding." Pet. 4. Patent Owner contends that "[u]nder *Phillips*, the term 'peak count (Pc)' in the claims must be read in light of the '689 patent's specification." Prelim. Resp. 4.

Based on the record before us, we determine that no claim term requires express construction for purposes of this Decision.

C. Asserted Obviousness over Shinozaki, Khatibi, Toshio and Kim

Petitioner asserts that claims 1–10 would have been obvious over the combined teachings of Shinozaki, Khatibi, and Toshio or Kim. Pet. 11–53.

1. Overview of Shinozaki

Shinozaki relates to an electrolytic copper foil in which a surface-roughened layer of copper or copper alloy having a particle size of 3 µm or less is formed on both surfaces of an untreated copper foil. Ex. 1004 ¶ 31. Shinozaki teaches that the surface-roughened layers have a surface roughness Rz of 1.0–5 µm or a surface roughness Ra of 0.25–0.7 µm, and "a difference of a roughness between the roughnesses Rz of the front and back surfaces being within 3 µm or a difference of roughness between the roughnesses Ra of the front and back surface being within 0.3 µm." *Id.* ¶¶ 31–32. Shinozaki further teaches that the electrolytic copper foil has "a tensile strength of 300 N/mm^2 or more at ordinary temperature, an elongation of 4.0% or more, and a tensile strength after an elapse of 15 hours at 150° C. of 250 N/mm^2 or more." *Id.* ¶ 50. According to Shinozaki, when "surfaces having the surface roughness Rz of 1 µm to 5 µm or the surface roughness Ra of 0.25 µm to 0.7 µm are obtained, . . . the adhesion between the copper foil (collector) and the active material is good, and a cycle characteristic of the battery can be improved." *Id.* ¶ 45.

2. Overview of Khatibi

Khatibi reports on a study investigating Young's modulus (E) and the coefficient of thermal expansion (CTE) "of free standing electrodeposited and rolled copper foils of 12μm to 200μm thickness . . . over a temperature range of 23°C to 200°C." Ex. 1006, 1.[8] Khatibi explains that the aim of the study "was to outline the impact of manufacturing process of thin copper foils on the temperature dependency of E and CTE up to 200°C and investigate the correlation between their properties in this temperature range." *Id.* at 2.

Khatibi's Table 2 is reproduced below.

Table 2: Results of E and CTE measurements for rolled and electrodeposited Cu foils as a function of test temperature

	CTE(ppm/K)			E(GPa)		
Designation	**RT**	**100°C**	**200°C**	**RT**	**100°C**	**200°C**
12μm-TPC-none	16,6	17,9	19,6	101		
18μm-TPC-none	14,8	20,3	27,6	100		
35μm-TPC-none	15,7	18,1	21,3	101		
12μm-TPC-300°C-30min	16,3	17,1	18,2	108	90	82
18μm-TPC-300°C-30min	17,1	18,1	19,7	101	84	77
35μm-TPC-300°C-30min	14,9	16,5	18,7	101	83	74
12μm-TPC-900°C-30min	15,5	17,2	19,5	87	75	68
18μm-TPC-900°C-30min	17,2	18,2	19,6	74	74	68
35μm-TPC-900°C-30min	14,3	17,1	20,9	79	61	68
12μm-DF-300°C-30min				111	98	69
18μm-DF-300°C-30min				93	87	67
35μm-DF-300°C-30min				96	79	58
12μm-DF-900°C-30min	15,8	16,9	18,39	105	84	68
18μm-DF-900°C-30min	17,1	18,0	19,2	86	77	58
35μm-DF-900°C-30min	16,9	17,4	18,1	90	69	61
200μm-DF-300°C-30min	16,7	16,8	16,9	120	106	91
Bulk copper	16,6	17,4	18,0	93	96	86

Table 2 reports the measured values of E and CTE for rolled copper foil (designated TPC) and electrodeposited foil (designated DF) of varying thickness (12, 18, 35, and 200 μm) and temperatures (room temperature, 100°C, and 200°C). Ex. 1006, 4. Khatibi concludes that "[a] significant thickness dependency of these parameters was not observed in the range

[8] We cite to the page numbers added by Petitioner to the bottom of each page.

of 12–200µm," and for electrodeposited foil "with thermally stable microstructure CTE is almost similar to that of bulk copper up to 200°C." *Id.* at 7.

3. *Overview of Toshio*

Toshio "relates to a negative electrode in which a negative electrode active material such as Si is directly formed on a negative electrode current collector, which is being considered for use in Li-ion secondary batteries, and a secondary battery using the same." Ex. 1014 ¶ 9. Toshio states that its "purpose is to provide a negative electrode and secondary battery that can achieve high capacity through charging and discharging, and can suppress decline in capacity even through repeated cycles compared to before." *Id.* Toshio states that, "[b]y using a negative electrode having a predetermined Si-based negative electrode active material . . . , it was discovered that the original high charge/discharge capacity was reliability obtained . . . and that the cycle characteristics could be improved." *Id.* ¶ 10. Toshio also states that "the charge/discharge cycle life can also be maintained for a long time" due to "the good adhesion between the current collector and the active material." *Id.* ¶ 11.

Toshio teaches that copper foil is used for the current collector base material "because the surface is not smooth and does not have gloss, and at least the surface forming the active material exhibits a rough surface." Ex. 1014 ¶ 53. Toshio further teaches that "it is preferable to use copper foil having a rough surface on the active material surface having a ten-point average roughness (Rz) of 1 µm or more as specified in JIS B0601-1994 as the current collector substrate," and "[t]hese rough surfaces may be either one side or both sides of the copper foil." *Id.* The cooper foil can also include a chromate layer, a benzotriazole layer, or a silane coupling treatment layer to provide heat resistance, rust prevention, and adhesion enhancement. *See, e.g., id.* ¶ 74.

4. *Overview of Kim*

Kim relates "to a copper foil for a current collector of a lithium secondary battery, which has a structure capable of preventing the generation of wrinkles on a surface of the copper foil." Ex. 1012 ¶ 3. Kim teaches that the copper foil preferably has a surface roughness R_z-JIS of 2μm or less, a weight deviation of 3% or less, a tensile strength of 30 to 40 kgf/mm^2, an elongation of 3 to 20%, and a thickness of 1 to 35 μm. *Id.* ¶¶ 13–17. Kim also teaches that "the surface of the copper foil is chromated to prevent corrosion." *Id.* ¶ 24.

5. *Analysis of Claim 1*

Petitioner contends that the combined teachings of Shinozaki, Khatibi, and Toshio or Kim disclose all of the limitations of independent claim 1. Pet. 13–46. Patent Owner responds that Petitioner does not establish that the proposed combination discloses the claimed CTE or tensile strength measurement parameters (limitations [1d] and [1e]), the claimed peak count (Pc) (limitation [1g]), or provide a sufficient reason to combine Khatibi with Shinozaki, and does not explain why the claimed features would be applied on both sides of the copper foil. Prelim. Resp. 19–62. We focus our analysis on limitations [1d] and [1e], as they are dispositive for purposes of this Decision.

a) *Limitation [1d]*

Limitation [1d] recites "a coefficient of thermal expansion of the electrolytic copper foil, which is measured using a thermomechanical analyzer (TMA) while heating the electrolytic copper foil from 30° C. to 190° C. at a speed of 5° C./min, ranges from 16 to 22 μm/(m·°C.)."

Ex. 1001, 13:52–56. Petitioner first asserts that "Khatibi provides CTE values for copper foil thickness ranging from 12-300μm as a function [of] temperature," and "Shinozaki discloses a copper foil having a thickness ranging from 8μm to 20μm." Pet. 13 (citing Ex. 1003 ¶¶ 45–46; Ex. 1007 ¶¶ 72–73). Petitioner then contends that "because Khatibi discloses the characteristics of the CTE of electrolytic copper foil having thicknesses similar to (or overlapping with) those of Shinozaki's electrolytic copper foils, Khatibi is a relevant disclosure that can relate to the CTE of Shinozaki's electrolytic copper foils in the combination." *Id.* at 15. For example, Petitioner asserts that "Khatibi discloses CTE values such as 15.8 ppm/K (corresponding to 15.8 μm/(m·°C.)), 16.9 ppm/K, and 18.39 ppm/K at 25 °C (room temperature), 100 °C, and 200 °C, respectively, for the electrolytic copper foil having a thickness of 12 μm." *Id.* at 16 (citing Ex. 1006, Table 2).

Petitioner contends that limitation [1d]'s requirement that CTE be measured using a TMA "is unlikely to significantly impact the CTE value, as variations in equipment and a heating speed of 5°C/min would not significantly alter the results." Pet. 16 (citing Ex. 1003 ¶¶ 56–58). Petitioner also contends that heating the electrolytic copper foil as recited in limitation [1d] "would have produced CTE values similar to Khatibi's CTE values at 25 °C, 100 °C, and 200 °C, as Khatibi's temperature range of 25-200 °C is comparable to the 30-190° C range recited in claim 1." *Id.* at 17 (citing Ex. 1006, Table 2). Petitioner further asserts that

> Dr. Randall explains that the "heating rate (the heating rate (5°C per minute) is typical for certain devices used to measure material expansion, such as a TMA (Thermomechanical Analyzer) or a dilatometer. Typically, these devices use ramp rates between 2°C and 20°C per minute, so the '5°C./min' recited

> in 1[d] is common and should not drastically affect the measurement results."

Id. (citing Ex. 1006, 3; Ex. 1003 ¶ 59).

We are not persuaded, on this record, that Petitioner adequately establishes that Khatibi discloses a CTE in the claimed range of 16 to 22 μm/(m·°C.). Petitioner's argument that Khatibi's reported values meet this claim limitation are based solely on Dr. Randall's testimony that Khatibi's measurement method would produce results that would not significantly differ from results determined using the claimed method. *See* Pet. 16–18 (citing Ex. 1003 ¶¶ 56–60). Dr. Randall's testimony, however, is largely conclusory and unsupported by adequate explanation and/or objective evidence. For example, Dr. Randall does not provide adequate explanation or objective evidence to support his opinion that Khatibi's use of a laser speckle based dilatometer instead of the claimed thermomechanical analyzer "is unlikely to significantly impact the CTE value" because "variations in equipment and a heating speed of 5° C/min would not significantly alter the results." Ex. 1003 ¶ 58. In particular, Dr. Randall neither explains what constitutes a "significant" impact on CTE, nor provides objective evidence to support his contention that equipment variations and heating differences would not "significantly alter" the resulting measurements. And although Dr. Randall opines that "the heating rate (5°C per minute) is *typical* for certain devices" such as a thermomechanical analyzer or dilatometer, and "*[t]ypically*, these devices use temperature ramp rates between 2°C and 20°C per minutes, so the '5° C./min' recited in [1d] is common and should not drastically affect the measurement results," Dr. Randall fails to point us to any evidence showing that these temperatures are "typical" or that the claimed heating rate is "common." *Id.* ¶ 59 (emphases added).

Accordingly, Dr. Randall's conclusory and unsupported testimony is entitled to little weight. *See* 37 C.F.R. § 42.65(a) ("Expert testimony that does not disclose the underlying facts or data on which the opinion is based is entitled to little or no weight."); *Xerox Corp. v. Bytemark, Inc.*, IPR2022-00624, Paper 12 at 5 (PTAB Feb. 10, 2023) (finding that "the Board was correct in giving little weight to Petitioner's expert because the expert declaration merely offered conclusory assertions without underlying factual support"); *Upjohn Co. v. Mova Pharm. Corp.*, 225 F.3d 1306, 1311 (Fed. Cir. 2000) ("Lack of factual support for expert opinion to factual determinations, however, may render the testimony of little probative value in a validity determination." (quoting *Ashland Oil, Inc. v. Delta Resins and Refractories, Inc.*, 776 F.2d 281, 294 (Fed. Cir. 1985))); *see also In re Ethicon, Inc.*, 844 F.3d 1344, 1348, 1352 (Fed. Cir. 2017) (concluding that the Board properly gave "little weight" to conclusory expert testimony of objective indicia).

Because Petitioner offers Dr. Randall's testimony to supply a limitation missing from the prior art, namely, the CTE measurement method, and we give Dr. Randall's unsupported and conclusory testimony little weight, we are not persuaded that Petitioner establishes a reasonable likelihood of showing that Khatibi discloses limitation [1d].

b) Limitation [1e]

Limitation [1e] recites "a tensile strength of the electrolytic copper foil, which is measured after a heat treatment at a temperature of 190° C. for 1 hour, ranges from 21 to 36 kgf/mm^2." Ex. 1001, 13:57–59. Petitioner asserts that "Shinozaki discloses tensile strength of the electrolytic copper foil being **30.6kgf/mm^2** (equivalent to 300 N/mm)," and "lists the tensile strength of untreated copper foil, ranging from **25.5 kgf/mm^2 to 28.6 kgf/mm^2** after an elapse of 15 hours at 150° C (converted from a range of 250–280 N/mm^2) and **31.6 kgf/mm^2** to **40.8 kgf/mm^2** at room temperature (converted from a range of 310–400 N/mm^2).” Pet. 18 (citing Ex. 1004, Table 2). Petitioner relies on Dr. Randall’s testimony to argue that “a heating temperature of 190° C for 1 hour would have had insignificant effect on changes on tensile strength compared to Shinozaki’s heating temperature of 150° C for 15 hours.” *Id.* at 18–19. Petitioner contends that

> this is supported by other prior art (e.g., Sano), where the majority (12 out of 17) of the high temperature (180°C) tensile strength data for the copper foils disclosed fall within the range of 21 to 36 kgf/mm^2 as well, and the remaining data bracket the claimed range of 21 to 36 kgf/mm^2 on both the high and low ends, thereby encompassing the entire claimed range of [1e].

Id. (citing Ex. 1008, Table 2; Ex. 1003 ¶ 61).

After reviewing the record, we are not persuaded that Petitioner adequately establishes that Shinozaki discloses tensile strength in the claimed range of 21 to 36 kgf/mm^2. As Petitioner notes, Shinozaki discloses tensile strengths of electrolytic copper foil (1) at room temperature and (2) after an elapse of 15 hours at 150° C. Pet. 18 (citing Ex. 1004 ¶ 50). Shinozaki also provides tensile strength values of untreated copper foils, also at room temperature and after heating at 150° C. for 15 hours. Ex. 1004 ¶¶ 89–90, Table 2. Petitioner relies on Dr. Randall’s testimony to argue that heating at 190° C. for 1 hour (as set forth in limitation [1e]) would insignificantly effect the tensile strength values reported in Shinozaki after heating at a temperature of 150° C. for 15 hours. Pet. 18–19.

Dr. Randall’s testimony with respect to Shinozaki’s tensile strength suffers from the same deficiencies as his testimony with respect to CTE discussed above. For example, Dr. Randall testifies that “a heating temperature of 190° C. for 1 hour would have had insignificant effect on changes on tensile strength," but does not provide adequate explanation or objective evidence to support this contention. Ex. 1003 ¶ 61. Dr. Randall does point to Sano,[9] and testifies that "the majority (12 out of 17) of the high temperature (180°C) tensile strength (*e.g.*, "Expansive force") data for the copper foils disclosed fall within the range of 21 to 36 kgf/mm^2 as well." *Id.* (citing Ex. 1008, Table 2). Dr. Randall identifies the temperature at which Sano's tensile strength (called Expansive force) was measured, but does not identify the amount of time the copper foil was treated at that temperature or provide any objective evidence to support the conclusion that the length of time and temperature of the heat treatment would have had an insignificant effect on the reported tensile strengths.[10] Thus, Dr. Randall's testimony that the claimed heating temperature and time duration would insignificantly effect tensile strength is conclusory and insufficiently supported, and we give it little weight. *See* 37 C.F.R. § 42.65(a); *Xerox*, IPR2022-00624, Paper 12 at 5; *Upjohn,* 225 F.3d at 1311; *Ethicon*, 844 F.3d 1344 at 1352.

Because Petitioner offers Dr. Randall's testimony to supply a limitation missing from the prior art, namely, heat treatment at 190° C for 1 hour, and we give Dr. Randall's unsupported and conclusory testimony little weight, we are not persuaded that Petitioner establishes a reasonable likelihood of showing that Shinozaki discloses limitation [1e].

c) Conclusion: Claim 1

For the reasons outlined above, we determine that Petitioner does not establish a reasonable likelihood of showing that claim 1 of the '689 patent

[9] US 2006/0191798 A1, issued Aug. 31, 2006 ("Sano," Ex. 1008).
[10] We also note that Sano reports Expansive force in Mpa, and Dr. Randall testifies that the values fall within the claimed range of 21 to 36 kgf/mm^2 without providing a conversion from Mpa to kgf/mm^2. *See* Ex. 1003 ¶ 61.

would have been obvious over the combined teachings of Shinozaki, Khatibi, and Toshio or Kim.

6. *Analysis of Claims 2–10*

Petitioner contends that claims 2–10 would have been obvious over the combined teachings of Shinozaki, Khatibi, and Toshio or Kim. Pet. 46–52. Claims 2–10 either depend from claim 1 (claims 2–5), include limitations that are the same as limitations [1d] and [1e] (claims 6 and 10), or depend from a claim that includes limitations that are the same as limitations [1d] and [1e] (claims 7–9). *See* Ex. 1001, 13:66–15:18. Accordingly, for the reasons set forth above with respect to claim 1, we determine that Petitioner does not establish a reasonable likelihood of showing that claims 2–10 of the ’689 patent would have been obvious over the combined teachings of Shinozaki, Khatibi, and Toshio or Kim.

D. *Asserted Obviousness over Kim, Khatibi, and Griesi*

Petitioner asserts that claims 1–10 would have been obvious over the combined teachings of Kim, Khatibi, and Griesi. Pet. 53–75.

1. *Overview of Griesi*

Griesi is a master’s thesis titled “Characterization of Electrodeposited Copper Foil Surface Roughness for Accurate Conductor Power Loss Modeling.” Ex. 1015, 1.[11] As part of his analysis, Griesi investigated several methods for characterizing or viewing the surface of a treated copper foil, including the use of a mechanical profilometer (Perthometer). *Id.* at 53–54. Figure 3.16 of Griesi is reproduced below:

[11] We refer to the page numbers added by Petitioner to the bottom-center of the page.

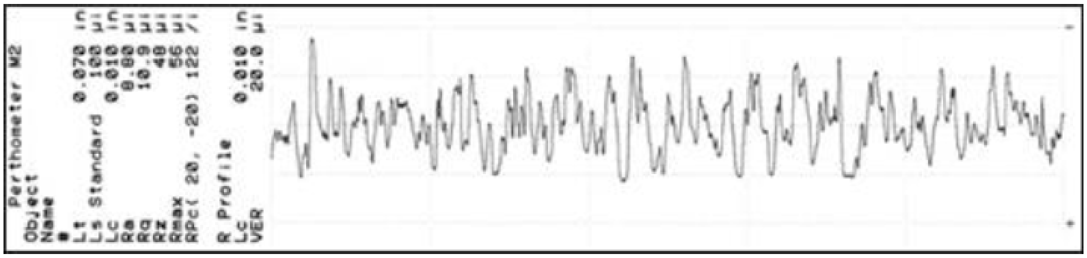


Figure 3.16 Printed Perthometer Surface Profile of Raw Untreated Copper Foil.

Figure 3.16, above, depicts a "Printed Perthometer Surface Profile of Raw Untreated Copper Foil." *Id.* at 54. On the left side of the printed receipt are values for Rz (48 µin) and RPc (122 peaks/in at criteria lines of 20, -20 µin), which Dr. Randall testifies equate to an Rz of 1.2 µm and a Pc (or Rpc) of 19.2 peaks per 4 mm using criteria lines of +0.5 µm and -.05 µm. *Id.*; Ex. 1003 ¶ 155.

2. Analysis of Claim 1

Petitioner contends that the combined teachings of Kim, Khatibi, and Griesi disclose all of the limitations of independent claim 1. Pet. 58–70. We focus our analysis on limitations [1d] and [1g], as they are dispositive on this record.

a) Limitation [1d]

Limitation [1d] recites "a coefficient of thermal expansion of the electrolytic copper foil, which is measured using a thermomechanical analyzer (TMA) while heating the electrolytic copper foil from 30° C. to 190° C. at a speed of 5° C./min, ranges from 16 to 22 µm/(m·°C.)." Ex. 1001, 13:52–56. Petitioner makes the same arguments regarding Khatibi's disclosures relating to limitation [1d] in this challenge that it made with respect to its challenge based on Shinozaki, Khatibi, and Toshio or Kim. *Compare* Pet. 63–65 *with id.* at 15–17. Petitioner does not rely on

Kim or Griesi to cure the deficiencies identified above with respect to limitation [1d] in Petitioner's challenge based on Shinozaki, Khatibi, and Toshio or Kim. *Id.* at 63–65. Accordingly, for the reasons set forth above (§ II.C.5.a), we are not persuaded that Petitioner establishes a reasonable likelihood of showing that Khatibi discloses limitation [1d].

b) Limitation [1g]

Limitation [1g] recites "a peak count (Pc) of each of the first and second surfaces of the electrolytic copper foil ranges from 3 to 92." Ex. 1001, 13:62–63. Petitioner contends that "Kim teaches that the electrolytic copper foil (e.g., *untreated* or *treated* copper foil) having Rz less than 2 μm is advantageous toward battery efficiency and performance," and, similarly, Griesi describes the use of untreated electrolytic copper foil with an Rz value less than 2 μm in printed circuit boards that are compatible with secondary batteries. Pet. 58–59 (citing Ex. 1012, claim 2, ¶¶ 13, 25, 27; Ex. 1003 ¶ 157). In particular, Petitioner notes that Griesi's Figure 3.16 describes an "Rz value of 1.2 μm." *Id.* at 59 (citing Ex. 1015, 53–54; Ex. 1003 ¶ 158). Petitioner asserts that "Dr. Randall explains that a POSITA would have also recognized another surface roughness-related parameter, Rpc, in Griesi as a potentially useful parameter that can be optimized to further enhance uniformity or generally improve Kim's copper foil surface, for example, to prevent wrinkles or achieve other advantageous effects." *Id.* (citing Ex. 1003 ¶ 159).

Although Dr. Randall demonstrates that Griesi's Pc (or Rpc) value is 19.2 over a 4 mm sampling length (Ex. 1003 ¶ 155), Petitioner does not contend that Griesi addresses this value, or indicates any benefit that might be derived from its use. Instead, Griesi's Pc value appears to be an incidental finding, which is not discussed or analyzed in the reference. *See*

Ex. 1015, 53–56. Petitioner does not persuasively explain why such an incidental, unexamined finding would lead a POSITA to import Griesi's Pc value into Kim's copper foil, absent a hindsight desire to reconstruct the claimed invention. As such, Petitioner's arguments with respect to Kim and Griesi are not persuasive. *See Cheese Sys. Inc. v. Tetra Pak Cheese and Powder Sys., Inc.*, 725 F.3d 1341, 1352 (Fed. Cir. 2013) ("Obviousness cannot be based on the hindsight combination of components selectively culled from the prior art to fit the parameters of the patented invention." (internal quotations marks omitted)). Thus, we are not persuaded, on this record, that the combined disclosures of Kim and Griesi teach all of the elements of limitation [1g].

c) Conclusion: Claim 1

For the reasons outlined above, we determine that Petitioner does not establish a reasonable likelihood of showing that claim 1 of the '689 patent would have been obvious over the combined teachings of Kim, Khatibi, and Griesi.

3. Analysis of Claims 2–10

Petitioner contends that claims 2–10 would have been obvious over the combined teachings of Kim, Khatibi, and Griesi. Pet. 70–75. Claims 2–10 either depend from claim 1 (claims 2–5), include limitations that are the same as limitation [1d] and [1g] (claims 6 and 10), or depend from a claim that includes limitations that are the same as limitations [1d] and [1g] (claims 7–9). *See* Ex. 1001, 13:66–15:18. Accordingly, for the reasons set forth above with respect to claim 1, we determine that Petitioner does not establish a reasonable likelihood of showing that claims 2–10 of the '689 patent would have been obvious over the combined teachings of Kim, Khatibi, and Griesi.

E. Discretionary Denial

Patent Owner contends that we should use our discretion to deny the Petition under 35 U.S.C. §§ 314(a) and 325(d). Prelim. Resp. 8–18. Because we determine that Petitioner does not establish a reasonable likelihood of prevailing based on the merits of its challenges, we need not address Patent Owner's arguments regarding discretionary denial.

III. CONCLUSION

Based on the arguments in the Petition and the Preliminary Response, and the evidence of record, we determine that Petitioner does not establish a reasonable likelihood of prevailing on its challenge that claims 1–10 of the '689 patent are unpatentable.

IV. ORDER

In consideration of the foregoing, it is hereby:

ORDERED that the Petition is *denied*, and no trial is instituted.

FOR PETITIONER:

Timothy W. Riffe
Hyun Jin In
FISH & RICHARDSON P.C.
riffe@fr.com
in@fr.com

FOR PATENT OWNER:

James M. Glass
Quincy Lu
David Elihu
QUINN EMANUEL URQUHART & SULLIVAN LLP
jimglass@quinnemanuel.com
quincylu@quinnemanuel.com
davidelihu@quinnemanuel.com

Michael D. Specht
Daniel E. Yonan
Jason A. Fitzsimmons
Jennifer Meyer Chagnon
Charles D. Hammond
STERNE, KESSLER, GOLDSTEIN & FOX PLLC
mspecht-PTAB@sternekessler.com
dyonan-PTAB@sternekessler.com
jfitzsimmons-PTAB@sternekessler.com
jchagnon-PTAB@sternekessler.com
chammond-PTAB@sternekessler.com