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Paper 14
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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.

IPR2025-00005
Patent 9,457,541 B2

Before RAE LYNN P. GUEST, JOHN G. NEW, and
JO-ANNE M. KOKOSKI, *Administrative Patent Judges*.

NEW, *Administrative Patent Judge*.

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

I. INTRODUCTION

Petitioner Solus Advanced Materials Co., Ltd. ("Petitioner") has filed a Petition (Paper 2, "Pet.") seeking *inter partes* review of claims 1–39 of U.S. Patent 9,457,541 B2 (Ex. 1001, the "'541 patent"). Patent Owner SK nexilis Co., Ltd. ("Patent Owner") timely filed a Preliminary Response. Paper 8 ("Prelim. Resp."). With our authorization, Petitioner filed a Reply Brief (Paper 10, "Reply"), as well as a Supplemental Brief (Paper 12, "Supp."), and Patent Owner filed a Sur-Reply Brief (Paper 11, "Sur-Reply") and a Reply to Petitioner's Supplemental Brief. (Paper 13, "Reply Supp.").

Under 35 U.S.C. § 314(a), the Board may not authorize an *inter partes* review "unless it determines that the information presented in the petition … 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." For the reasons we explain below, we deny institution of *inter partes* review of the '541 patent.

II. BACKGROUND

A. Real Parties-in-Interest

Petitioner identifies Volta Energy Solutions Canada Inc., Volta Energy Solutions Europe KFT, Volta Energy Solutions Hungary KFT, and Volta Energy Solutions S.A.R.L. as its real parties-in-interest. Pet. 74. Patent Owner identifies itself, SK nexilis Co., Ltd. as its real party-in-interest. Paper 3, 2.

B. Related Matters

Petitioner and Patent Owner identify *SK nexilis Co., Ltd. v. Solus Advanced Materials Co., Ltd. et al.*, Case 2-23-cv-00539 (E.D. Tex.), filed November 21, 2023, as a related matter involving the ’541 patent. Pet. 74; Paper 3, 2.

Patent Owner additionally identifies the following proceedings before the Board as related matters:

1. *Solus Advanced Materials Co., Ltd. v. SK nexilis Co., Ltd.*, IPR2024-01460 (institution of *inter partes* review denied April 22, 2025).
2. *Solus Advanced Materials Co., Ltd. v. SK nexilis Co., Ltd.*, IPR2024-01461 (institution of *inter partes* review denied April 23, 2025).
3. *Solus Advanced Materials Co., Ltd. v. SK nexilis Co., Ltd.*, IPR2024-01462 (institution of *inter partes* review denied April 25, 2025).
4. *Solus Advanced Materials Co., Ltd. v. SK nexilis Co., Ltd.*, IPR2024-01463 (institution of *inter partes* review granted April 25, 2025).

Paper 3, 2.

C. The Asserted Grounds of Unpatentability

Petitioner contends that claims 1–4 of the ’541 patent are unpatentable, based upon the following grounds:

Ground	Claim(s) Challenged	35 U.S.C. §	Reference(s)/Basis
1	1–4	103	Kim[1], Hara[2], Otsuka[3]
2	1–4	103	Ye[4], Hara, Otsuka
3	1–4	103	Hirose[5], Hara, Otsuka or Matsuda[6]

Petitioner also relies upon the Declaration of Dr. Jack Josefowicz (the "Josefowicz Declaration," Ex. 1003).

D. The '541 Patent (Ex. 1001)

The '541 patent relates to a copper foil for a current collector of a lithium secondary battery that has a crystalline structure. Ex. 1001, Abstr. The '541 patent discloses that, in lithium secondary batteries, a copper foil is commonly used as the material of the anode current collector, and that the copper foil is generally coated with active material such as a carbon-based

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[1] J. Kim et al., *Effects of Organic Additives on Residual Stress and Surface Roughness of Electroplated Copper for Flexible PCB*, 6(4) CORROSION SCI. AND TECHNOL., 154–58 (2007) ("Kim") Ex. 1018.

[2] K. Doihara et al., Japanese Unexamined Patent Application Publication 2003-51340 (P203-51340A), February 21, 2003) ("Hara") Ex. 1009.

[3] Otsuka et al. (US2004/002906 A1, February 12, 2004) ("Otsuka") Ex. 1010.

[4] X. Ye et al., Role of Overpotential on Texture, Morphology and Ductility of Electrodeposited Copper Foils for Printed Circuit Board Applications, 139(6) J. ELECTROCHEM. SOC. 1592–1600 (1992) ("Ye") Ex. 1013.

[5] Hirose et al. (US 2009/00061326 A1, March 5, 2009) ("Hirose") Ex. 1007.

[6] Matsuda et al. (US 2010/0038115 A1, February 18, 2010) ("Matsuda") Ex. 1012.

slurry. *Id.* at col. 1, ll. 38–41. The ’541 patent discloses that the copper foil is made by making an electrodeposited copper foil by means of electroplating, and then conducting a post-processing to give peel strength to the original foil. *Id.* at col. 1, ll. 41–44.

The ’541 patent discloses that the characteristics of a lithium secondary battery are greatly changed in accordance with the surface state of the copper foil used as the anodal current collector, and that it is very important to improve the surface characteristics, such as wrinkle characteristics, in order to improve the battery’s yield. Ex. 1001, col. 1, ll. 53–57. According to the ’541 patent, surface irregularities in the foil, such as wrinkles, can result in the foil not being uniformly coated with the active material due to the irregularity of the surface shape. *Id.* at col. 1, ll. 58–60 (citing Fig. 1). The ’541 patent discloses that this may cause a short-circuit or separate the active material from the copper foil during the battery charging or discharging process. *Id.* at col. 1, ll. 60–62.

The ’541 patent discloses that the purpose of its claimed copper foil for a current collector of a lithium secondary battery with a crystal structure is that it is capable of decreasing the generation of wrinkles at a surface of the copper foil. Ex. 1001, col. 2, ll. 1–4. According to the ’541 patent, this purpose is achieved by optimizing such factors as surface roughness, weight deviation, tensile strength, elongation, and thickness, so as to effectively decrease the generation of wrinkles at the surface of the foil. *Id.* at col. 2, ll. 5–10.

The ’541 patent discloses that, if the texture coefficients of the various crystalline angle surfaces are not within specific ranges, many undesirable wrinkles are created in a width direction of the copper foil and, accordingly, the adhesion of active material to the surface of the copper foil may be deteriorated when the active material is coated. Ex. 1001, cols. 3–4, ll. 51–3. The texture coefficient ("TC") is determined employing x-ray diffraction ("XRD") to obtain a diffraction intensity peak for each crystal surface, and then comparing the diffraction intensity peak with a criterion peak to convert it within the range defined by following Equation 1, below:

$$TC(hkl) \geq \frac{\frac{I(hkl)}{I_0(hkl)}}{\frac{1}{n}\Sigma\frac{I(hkl)}{I_0(hkl)}}$$

Equation 1

where *I(hkl)* is the measured diffraction intensity with respect to the (*hkl*) surface, and $I_0(hkl)$ represents a standard diffraction intensity of an ASTM (American Society of Testing Materials) standard powder-shaped diffraction datum. *Id.* at col. 4, ll. 3–12.

Specifically, the '541 patent discloses that the crystalline structure of the copper foil should satisfy a condition such that: (1) the ratio of the sum of texture coefficients of the (111) surface and the (200) surface, to the total sum of texture coefficients of the (111), (200) and (220) surfaces is 60 to 85%; (2) the ratio of the texture coefficient of the (111) surface to the total sum of texture coefficients of the (111), (200) and (220) surfaces should be 18 to 38%; (3) the ratio of the texture coefficient of the (200) surface to the total sum of texture coefficients of the (111), (200) and (220) surfaces should be 28 to 62%; and (4) the ratio of the texture coefficient of the (220) surface to the total sum of texture coefficients of the (111), (200) and (220) surfaces should be 15 to 40%. Ex. 1001, col. 3, ll. 23–33. For the sake of simplicity, we present these ratios as formulae below:

(1): (111) + (200)/(100) + (200) + (220) = 65–80%

(2): (111)/(100) + (200) + (220) = 18–38%

(3): (200)/(100) + (200) + (220) = 28–62%

(4): (220)/(100) + (200) + (220) = 14–40%

The ’541 patent discloses that such a crystalline structure may be obtained by controlling additives or plating conditions during the electroplating process for making a copper foil. Ex. 1001, col. 3, ll. 33–36. Specifically, the ’541 patent reveals that the plating solution for obtaining the crystalline structure includes copper sulfate, sulfuric acid and chlorine, to which is added at least two kinds of organic additives selected from: (1) a gelatin-based compound with a molecular weight of 1,000 to 100,000 or; (2) a cellulose-based compound in addition to a mercapto compound, either of which is added in the range of 1 to 50 ppm, respectively. *Id.* at col. 3, ll. 39–44.

E. Representative Claims

Claim 1 is the sole independent claim of the ’541 patent, and is representative of the challenged claims. Claim 1 recites:

> [1pre] A copper foil for a current collector of a lithium secondary battery,
>
> [1a] wherein, in a crystalline structure, a ratio of a sum of texture coefficients of a (111) surface and a (200) surface to a total sum of texture coefficients of the (111) surface, the (200) surface and a (220) surface is 60 to 85%, a ratio of a texture coefficient of the (111) surface to the total sum of texture coefficients of the (111) surface, the (200) surface and the (220) surface is 18 to 38%, a ratio of the texture coefficient of the (200) surface to the total sum of texture coefficients of the (111) surface, the (200) surface and the (220) surface is 28 to 62%, and a ratio of the

texture coefficient of the (220) surface to the total sum of texture coefficients of the (111) surface, the (200) surface and the (220) surface is 15 to 40%,

[1b] wherein the texture coefficient satisfies the following equation:

$$TC(hkl) \geq \frac{\frac{I(hkl)}{I_0(hkl)}}{\frac{1}{n}\Sigma\frac{I(hkl)}{I_0(hkl)}}$$

[1c] wherein the copper foil has a weight deviation of 3% or less, and

[1d] wherein the copper foil has a tensile strength of 30 to 40 kgf/mm^2,

[1e] so as to prevent the generation of wrinkles at a surface of the copper foil.

Ex. 1001, cols. 5–6, ll. 53–47.[7]

F. Priority History of the '541 Patent

The '541 patent issued from U.S. Patent Application Ser. No. 13/722,585 (the "'585 application"), filed on December 20, 2012, and cites the priority benefit of, *inter alia*, U.S. Patent Application Ser. No. 13/029,656, which was filed on February 17, 2011. Ex. 1001, codes (21), (22), (63).

Claims 1–4 of the '541 patent were allowed on June 3, 2016, and the patent issued on October 4, 2016. Ex. 1002, 16; Ex. 1001, code (45).

[7] We have added Petitioner's designations for each limitation of claim 1 and employ them in our analyses below.

III. ANALYSIS

A. Claim Construction

The Board applies the same claim construction standard that would be used to construe the claims in a civil action under 35 U.S.C. § 282(b). *See* 37 C.F.R. § 100(b) (2020). Under that standard, claim terms "are generally given their ordinary and customary meaning" as understood by a person of ordinary skill in the art at the time of the invention. *Phillips v. AWH Corp.*, 415 F.3d 1303, 1312–13 (Fed. Cir. 2005) (en banc). "In determining the meaning of the disputed claim limitation, we look principally to the intrinsic evidence of record, examining the claim language itself, the written description, and the prosecution history, if in evidence." *DePuy Spine, Inc. v. Medtronic Sofamor Danek, Inc.*, 469 F.3d 1005, 1014 (Fed. Cir. 2006) (citing *Phillips*, 415 F.3d at 1312–17). Extrinsic evidence is "less significant than the intrinsic record in determining 'the legally operative meaning of claim language.'" *Phillips*, 415 F.3d at 1317 (quoting *C.R. Bard, Inc. v. U.S. Surgical Corp.*, 388 F.3d 858, 862 (Fed. Cir. 2004)).

Neither Petitioner nor Patent Owner offers any express construction of any of the claim terms of the '541 patent beyond that set forth by the *Phillips* standard at this time. *See* Pet. 21; Prelim. Resp. 3.

We determine that no express construction of any claim term beyond the ordinary and customary meaning, as understood by a person of ordinary skill in the art at the time of the invention, is necessary for the purpose of rendering this Decision. *Nidec Motor Corp. v. Zhongshan Broad Ocean Motor Co.*, 868 F.3d 1013, 1017 (Fed. Cir. 2017).

B. A Person of Ordinary Skill in the Art

Petitioner contends that a person of ordinary skill in the art, as of the effective filing date of the ’541 patent, would have had at least an undergraduate degree in materials science, chemical engineering, electrical engineering, or a 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. 6. Petitioner adds that additional education, such as a graduate degree, could compensate for less work experience and, conversely, that additional work experience could compensate for less formal education. *Id.* (citing Ex. 1003 ¶ 16).

Patent Owner responds that, for the purposes of this Decision, it applies Petitioner’s proposed level of skill for a person of ordinary skill in the art. Prelim. Resp. 3.

Petitioner’s proposed definition of the level of ordinary skill in the art appears to be consistent with the level of skill presented in the cited prior art. *See, e.g.*, Exs. 1007, 1008, 1009, 1010, 1012, 1013, 1018; *see also Okajima v. Bourdeau*, 261 F.3d 1350, 1355 (Fed. Cir. 2001) (holding that the prior art itself may reflect an appropriate level of skill in the art). For the purposes of this Decision, then, we adopt Petitioner’s proposed definition as defining a person of ordinary skill in the art.

C. Ground 1: Alleged Obviousness of Claims 1–4 over Kim, Hara, and Otsuka

1. Principles of law

A patent claim is unpatentable under 35 U.S.C. § 103 if “the differences between the claimed invention and the prior art are such that the claimed invention as a whole would have been obvious before the effective filing date of the claimed invention to a person having ordinary skill in the art to which the claimed invention pertains." *KSR Int'l Co. v. Teleflex Inc.*, 550 U.S. 398, 406 (2007). The question of obviousness is resolved on the basis of underlying factual determinations including: (1) the scope and content of the prior art; (2) any differences between the claimed subject matter and the prior art; (3) the level of ordinary skill in the art; and (4) objective evidence of nonobviousness. *Graham v. John Deere Co.*, 383 U.S. 1, 17–18 (1966).

In determining obviousness when all elements of a claim are found in various pieces of prior art, "the factfinder must further consider the factual questions of whether a person of ordinary skill in the art would be motivated to combine those references, and whether in making that combination, a person of ordinary skill would have had a reasonable expectation of success." *Dome Patent L.P. v. Lee*, 799 F.3d 1372, 1380 (Fed. Cir. 2015); *see also WMS Gaming, Inc. v. Int'l Game Tech.*, 184 F.3d 1339, 1355 (Fed. Cir. 1999) ("When an obviousness determination relies on the combination of two or more references, there must be some suggestion or motivation to combine the references."). "Both the suggestion and the expectation of success must be founded in the prior art, not in the applicant's disclosure." *In re Dow Chemical Co.*, 837 F.2d 469, 473 (Fed. Cir. 1988); *see also In re Magnum Oil Tools Int'l, Ltd.*, 829 F.3d 1364, 1381 (Fed. Circ. 2016) (finding a party that petitions the Board for a determination of unpatentability based on obviousness must show that "a skilled artisan would have been motivated to combine the teachings of the prior art references to achieve the claimed invention, and that the skilled artisan would have had a reasonable expectation of success in doing so") (internal quotations and citations omitted).

An obviousness analysis "need not seek out precise teachings directed to the specific subject matter of the challenged claim, for a court can take account of the inferences and creative steps that a person of ordinary skill in the art would employ." *KSR*, 550 U.S. at 418; *see In re Translogic Tech., Inc.*, 504 F.3d 1249, 1259 (Fed. Cir. 2007). In *KSR*, the Supreme Court also stated that an invention may be found obvious if trying a course of conduct would have been obvious to a person of ordinary skill in the art:

> When there is a design need or market pressure to solve a problem and there are a finite number of identified, predictable solutions, a person of ordinary skill has good reason to pursue the known options within his or her technical grasp. If this leads to the anticipated success, it is likely the product not of innovation but of ordinary skill and common sense. In that instance the fact that a combination was obvious to try might show that it was obvious under § 103.

550 U.S. at 421. "*KSR* affirmed the logical inverse of this statement by stating that § 103 bars patentability unless 'the improvement is more than the predictable use of prior art elements according to their established functions.'" *In re Kubin*, 561 F.3d 1351, 1359–60 (Fed. Cir. 2009) (citing *KSR*, 550 U.S. at 417).

<u>2.</u> <u>Overview of Kim (Ex. 1018)</u>

Kim is a study entitled *Effects of Organic Additives on Residual Stress and Surface Roughness of Electroplated Copper for Flexible PCB* (Printed Circuit Board) published in the journal Corrosion Science and Technology in 2007. Kim describes studies investigating the effects of the addition of organic additives, such as inhibitors, levelers, and accelerators on the surface roughness and residual stress of electroplated copper as thick as 8 μm. Ex. 1018, Abstr. Kim teaches that flexible printed circuit boards comprise a polyimide film with a low dielectric constant as an insulator and electroplated copper film as a conductor. *Id.* at 154. Kim teaches that an electroplated copper film, requires treatment with organic additives to have both low residual stress and surface roughness with high reliability. *Id.*

Kim teaches that organic inhibitors, such as polyethylene glycol, polyethylene oxide, polypropylene glycol (PPG), and gelatin suppress charge transfer on the electrode surface during plating. Ex. 1018, 154. Levelers, such as benzotriazole, Janus green B, and other organic compounds that include nitrogen, also suppress charge transfer on the electrode surface during plating, but are also preferentially adsorbed onto sites such as protrusions and corners to prevent formation of protrusions. *Id.* Sulfur-containing accelerators, such as 3-mercapto-1-propane sulfonic acid, Bis-(3-sodiumsulfopropyl) disulfide, and 3-N, N-dimethylaminodithiocarbamoyl-1-propanesulphonic acid, promote charge transfer on the electrode surface and are known to retard surface diffusion, resulting in a brighter and smoother plated surface. *Id.*

Kim teaches that increasing concentrations of inhibitor and leveler decreased surface roughness, with the leveler more effectively decreasing surface roughness (R_Z) from about 640 nm to 40 nm. Ex. 1018, 155. Kim teaches that the effectiveness of the leveler in decreasing surface roughness is due to the difference in the inhibition of electroplating. *Id.* Low concentrations of accelerator, on the other hand, like the other additives, caused surface roughness to be low if the concentration of the leveler was between 0 and 5 ppm. *Id.* However, when a critical concentration of the accelerator was exceeded, surface roughness increased. *Id.*

Kim demonstrates the relationship between residual stress and the preferred XRD planes during plating, as depicted in Table 1 below:

Table 1. Relation between residual stress and preferred plane formed during plating (I: inhibitor, L: leveler, A: accelerator).

Electrolyte	Texture coefficient			Residual stress (MPa)	Preferred plane
	(111)	(200)	(220)		
300ppm I + 20ppm L	0.23	0.30	**2.47**	6.92	(220)
300ppm I + 20ppm L + 5ppm A	0.88	**1.15**	0.97	0	(200)

<u>3.</u> <u>Overview of Hara (Ex. 1009)</u>[8]

Hara is Unexamined Japanese Patent Application Publication P2003-51340A entitled *Lithium Secondary Battery* and published February 21, 2003. Ex. 1009, codes (11), (43), (54). Hara is directed to "lithium secondary batteries with small variations in battery capacity and long life." *Id.* at Abstr.

Hara teaches, in relevant part, a negative electrode formed on an electrolytic copper foil with a negative electrode mixture layer containing amorphous carbon. Ex. 1009, Abstr. Electrolytic copper foil was used for the negative electrode current collector with a variation in weight per unit area of 2% or less and an elongation rate of 5% or less when pressing the negative electrode mixture layer. *Id.* Hara teaches that the variation in the thickness of the negative electrode current collector is suppressed, and the

[8] The original Hara reference (Ex. 1008) was published in Japanese. A certified English translation (Ex. 1009) has been provided by Petitioner, and Patent Owner does not dispute the accuracy of this translation. We employ the latter exhibit in this Decision.

distortion of the electrolytic copper foil is small, preventing the occurrence of micro-short circuits. *Id.*

Hara teaches that, traditionally, the negative electrode current collector of lithium secondary batteries is composed of rolled copper foil. Ex. 1009 ¶ 6. However, Hara discloses:

> [L]arge lithium secondary batteries for EVs and the like are repeatedly charged and discharged at a large current, and in order to ensure high capacity and high output, it is necessary to make the positive and negative electrodes thin to increase the opposing area, or to increase the bulk density of the negative electrode mixture layer to make the conductive network stronger and reduce resistance. Therefore, the positive and negative electrodes are long and wound many times. As the thickness of the rolled copper foil becomes thinner, the number of times of rolling increases, and the variation in thickness in the rolling direction and distortion of the rolled copper foil also increase.

Id. ¶ 7. Hara teaches that this can: (1) make it difficult to accommodate the foil in a battery container; (2) cause variation in battery capacity; (3) cause uneven electrode reactions leading to premature battery life; or (4) cause heat generation due to current concentration, compromising the safety of the battery. *Id.*

To solve this problem, Hara discloses, relevantly:

> [A] lithium secondary battery, comprising … a negative electrode in which a negative electrode mixture layer containing a carbon material capable of doping and dedoping lithium ions by charging and discharging is formed on a negative electrode current collector, and an organic electrolyte solution that allows the movement of the lithium ions, wherein the negative electrode current collector is characterized by an electrolytic copper foil having a weight variation of 2% or less per unit area and an elongation of 5% or less before pressing the negative electrode mixture layer to a predetermined bulk density.

Ex. 1009 ¶ 11. To make this electrode, Hara teaches making a slurry of Carbotron P powder, polyvinylidene fluoride, and N-methyl-2-pyrrolidone. *Id.* ¶ 16. Hara teaches that this slurry is applied to both sides of the electrolytic copper foil (negative electrode current collector) of a predetermined thickness with a weight variation of 2% or less per unit area, dried, and pressed at a predetermined pressure using a roll press machine set to a surface temperature of 120°C to form a negative electrode mixture layer, and cut to obtain a negative electrode having a width of 305 mm, a predetermined length, a predetermined bulk density, and a negative electrode mixture layer (active material coated portion) of a predetermined thickness. *Id.*

4. Overview of Otsuka (Ex. 1010)

Otsuka is U.S. Patent Application Ser. No. US 2004/0029006 A1, entitled *Electrodeposited Copper Foil and Electrodeposited Copper Foil for Secondary Battery Collector*, and published on February 12, 2004. Ex. 1010, codes (10), (54), (43). Otsuka is directed to:

> [A]n electrodeposited copper foil having an extremely smooth surface roughness at the deposition surface, having an extremely fine crystal structure, and yet not having too high an ordinary temperature tensile strength, superior in elongation, maintaining a stable strength without softening by heat even after heat treatment.

Id. at Abstr. Specifically, Otsuka teaches that its claimed foil has:

> [A] surface roughness at a deposition surface at ordinary temperature smaller than 2.5 μm in terms of 10-point average roughness R_z, having a minimum distance between peaks of a base foil peak of at least 5 μm, having an ordinary temperature tensile strength of not more than 40 kg/mm^2, and having a drop in

> ordinary temperature tensile strength after heat treatment at 130° C. for 15 hours of less than 15%.

Ex. 1010 ¶ 20. Otsuka discloses that its electrodeposited foil composition is made in the following manner:

> 7 ppm of low molecular weight gelatin having an average molecular weight of 3000, 3 ppm of hydroxyethyl cellulose, and 1 ppm of sodium 3-mercapto 1-propane sulfonate were added to a c[o]pper sulfate electrolyte with sulfuric acid containing 280 g/liter of copper sulfate pentahydrate, 100 g/liter of sulfuric acid, and 35 ppm of chlorine ions. A foil was produced using this under conditions of an electrolyte temperature of 55° C., a flow rate of 0.3 m/min, and a current density of 50 A/dm^2. At this time, the electrolyte was passed through an activated carbon tower before entering the electrolysis tank and was brought to a boil after leaving the electrolysis tank after the end of the electrolysis, then was adjusted to the desired copper concentration, free sulfuric acid concentration, and chlorine ion concentration and provided again for electrolysis in a continuous cycle. Due to this, electrodeposited copper foils having a thickness of 35 μm for measurement of foil properties and having a thickness of 12 μm for use for a secondary battery electrode were produced.

Id. ¶ 35.

5. <u>Petitioner's arguments</u>

a. Claim 1

i. [1pre]

Petitioner argues that, to the extent that the preamble is limiting upon the claim, Kim discloses an electroplated copper foil (e.g., electrolytic copper foil) for use in PCBs, which is also compatible for use in the current collector of a lithium-ion secondary battery. Pet. 17. Petitioner asserts that such use compatibility of electrolytic copper foil between the PCB and the secondary batteries was well-known in the contemporaneous art. *Id.* (citing

Ex. 1022 ¶ 107; Ex. 1023 ¶¶ 1, 5, 12, 66; Ex. 1012 ¶¶ 10, 12, 52). Petitioner therefore contends that, in combination with Hara and Otsuka, Kim discloses a copper foil for a current collector of a lithium-ion secondary battery. *Id.* (citing Ex. 1003 ¶ 65).

ii. [1a]–[1b]

Petitioner points to the testimony of its declarant, Dr. Josefowicz, who states that the texture coefficient is a measure of the prominence of the XRD peak of a given plane, relative to other planes. Pet. 18 (citing Ex. 1003 ¶ 67). Petitioner also points to Table 1 of Kim, which is reproduced again below, which shows the texture coefficients for two of Kim's copper foils[9]:

Table 1. Relation between residual stress and preferred plane formed during plating (I: inhibitor, L: leveler, A: accelerator).

Electrolyte	Texture coefficient			Residual stress (MPa)	Preferred plane
	(111)	(200)	(220)		
300ppm I + 20ppm L	0.23	0.30	**2.47**	6.92	(220)
300ppm I + 20ppm L + 5ppm A	0.88	**1.15**	0.97	0	(200)

Id. (citing Ex. 1018, Table 1).

According to Petitioner, Kim describes how the use of 5 ppm accelerator (+5 ppm A) produces a crystal orientation with: (1) reduced internal stress; and (2) a smoothened surface, exhibiting corresponding TC ratios that fall within the claimed range of the '541 patent. Pet. 18 (citing Ex. 1018, 158, Table 1). As proof of this, Petitioner presents Table 2 of the Petition, which is reproduced below:

9 Petitioner's statement is technically inaccurate. The two examples of Table 1 represent a foil synthesized in the same manner, but treated during electroplating with different organic additives to the plating solution.

Table 2. Kim ratio check

Ratio	Claimed Lower Limit	Ratio Value	Claimed Upper Limit
1st ratio = (111) + (200)	60%	**67.7%**	85%
2nd ratio = (111)	18%	**29.3%**	38%
3rd ratio = (200)	28%	**38.3%**	62%
4th ratio = (222)	15%	**32.3%**	40%

Pet. 19.[10]

iii. [1c]

Petitioner notes that, first, weight variation in Hara corresponds to the weight deviation recited in [1c]. Petitioner notes that the ’541 patent discloses that:

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

Pet. 20 (citing Ex. 1001, col. 4, ll. 30–39). Petitioner’s declarant, Dr. Josefowicz, explains that “the ’541 patent’s determination of ‘weight deviation’ first measures the weight of a standard area and ‘converts the weight into a weight of the copper foil per unit area,’” in which the “‘weight

[10] We note that, while Petitioner’s calculations of the ratios appear to be correct, for the sake of completeness, each of the ratios should be represented as being the stated peak amplitude, or sum of the peak amplitudes (e.g., (111) + (200)), divided by the sum of the amplitudes for the (111), (200), and (220) peaks, e.g., (111) + (200)/(111) + (200) + (220).

deviation'" is the equivalent of Hara's "'weight variation per unit area.'" *Id.* (quoting Ex. 1003 ¶ 76).

Petitioner argues that Hara accordingly teaches using an electrolytic copper foil for the negative electrode current collector "with a variation in weight per unit area of 2% or less" and provides specific examples such as 1.0% and 2.0% in its Examples 1 and 2. Pet. 20 (citing Ex. 1009, Abstr. ¶¶ 11, 12, 15, 27, 29, 48; Ex. 1003 ¶ 77).

Petitioner contends that Hara additionally explains that advantages of using an electrolytic copper foil with a weight variation per unit area of 2% or less, include: (1) suppression of the variation in thickness of the negative electrode current collector; (2) uniformity of the electrode reaction; and (3) realization of excellent cycle life characteristics of batteries. Pet. 20 (citing Ex. 1009 ¶¶ 12, 48, 50, 51; Ex. 1003 ¶ 78).

Petitioner adds that there would have been sufficient motivation for a person of ordinary skill in the art to apply Hara's teachings of weight variation to Kim's electrolytic copper foil, and that a skilled artisan would have had a reasonable expectation of success in combining the references. Pet. 21 (citing Ex. 1003 ¶ 79).

iv. 1[d]

Petitioner argues that Otsuka teaches an electrolytic copper foil having a tensile strength of "not more than 40 kg[f]/mm^2" and lists examples of tensile strengths such as 32, 36, and 38 kgf/mm^2 in Table 1, which fall within the teachings of the '541 patent's claimed tensile strength range of 30 to 40 kgf/mm^2. Pet. 22 (citing Ex. 1010 ¶¶ 20, 46, Table 1). Petitioner contends that Otsuka additionally teaches that electrolytic copper foils having such tensile strength maintains or enhances adhesion between the current collector and the active material of the battery, which results in superior "charge/discharge cycle life and productivity" of secondary batteries. *Id.* (citing Ex. 1010, Abstr., ¶¶ 20, 29, 30, 31, 33; Ex. 1003 ¶ 81).

Petitioner contends that there would have been sufficient motivation for a person of ordinary skill in the art to apply Otsuka's teachings of tensile strength to Kim's electrolytic copper foil and that a skilled artisan would have had a reasonable expectation of success in combining the teachings of the references. Pet. 23 (citing Ex. 1003 ¶ 82). Petitioner adds that Otsuka's teaching of tensile strengths of 30 to 40 kgf/mm^2 indicates a wide range, and that it was conventional in the art to produce or obtain electrolytic copper foils that fall within, or overlap with, this tensile strength range. *Id.* at 23–24 (citing Ex. 1003 ¶ 85 (citing Ex. 1023, Table 2; Ex. 1028, Table 2, claim 5 ¶¶ 18, 50, 51)).

Petitioner also points to the testimony of Dr. Josefowicz, who states that it was also conventional in the art to vary the electrolyte concentration, electrolysis plating parameters, temperature, and the use of organic and inorganic additives, in order to obtain a copper foil with a tensile strength falling within the claimed tensile strength range, as this range was well known, at least since 1974, as illustrated below. Pet. 24 (citing Ex. 1025, 18, Table 2; Ex. 1003 ¶ 85).

v. 1[e]

Petitioner argues that limitation 1[e] should not be accorded patentable weight. Pet. 24–25 (citing MPEP § 2114; also citing, e.g., *Hewlett-Packard Co. v. Bausch & Lomb Inc.*, 909 F.2d 1464, 1469 (Fed. Cir. 1990)).

However, argues Petitioner, to the extent that the wrinkle prevention purpose is limiting, the limitation is rendered obvious "by the Patentee's own admission." Pet. 25. By way of example, Petitioner notes that, during prosecution of the '541 patent, Patent Owner (the then-Applicant) contended multiple times that "referring to Table 1 of this application, all Examples 1-7 satisfy the numerical ranges of all conditions, defined in Claim 1 of this application, thereby preventing wrinkles." *Id.* (quoting Ex. 1002, 35). Petitioner asserts that Patent Owner also asserted that "the texture coefficient ratio, the tensile strength and the weight deviation are entirely satisfied so that the number of generated wrinkles is 0 (zero)." *Id.* (quoting Ex. 1002, 37). Petitioner therefore asserts that Patent Owner contended that satisfying the structural limitations [1a]–[1d] would allegedly result in the prevention of wrinkles. *Id.* (citing Ex. 1002, 36) ("[T]he factors which prevent wrinkles...are a texture coefficient ratio, a tensile strength and a weight deviation").

Petitioner again argues that the combination of the references satisfies all conditions (or claimed ranges) of the texture coefficient ratio, the tensile strength and the weight deviation ranges. Pet. 25–26. Therefore, argues Petitioner, Patent Owner's acknowledgments demonstrate that limitation [1e] is not an additional requirement imposed by the claims. *Id.* at 26 (citing Ex. 1003 ¶¶ 86–87; *Alcon Research, Ltd. v. Apotex Inc.*, 687 F.3d 1362, 1369 (Fed. Cir. 2012)).

Alternatively, Petitioner contends, if the language of limitation 1[e] is limiting upon the claims, a person of ordinary skill in the art would have understood that Kim relates how the proper concentrations of different additives—an inhibitor, a leveler, and an accelerator—during electroplating produce films which are so smooth it is difficult to measure the surface roughness. Pet. 26. Petitioner points to Kim's Figure 5(b), which, Petitioner contends, illustrates a very smooth surface; the correspondingly measured surface roughness (R_Z) is equal to or less than 0.050 μm (50 nm). *Id.* Petitioner adds that Dr. Josefowicz explains that such a smooth surface is not possible if there are wrinkles on the surface. *Id.* (citing Ex. 1003 ¶ 89).

Petitioner additionally argues that Hara confirms that the copper foil with an elongation of 5% or less, addresses wrinkle formation issues to at least some extent. Pet. 27. By way of example, Petitioner argues that the purpose of Hara is to ensure controlled elongation of copper foil, which helps prevent the formation of wrinkles during the winding process. *Id.* Petitioner contends that, by using copper foil with minimal weight variability and controlled elongation, the risk of undulation and misalignment, which can lead to wrinkles, may be reduced. *Id.* (citing Ex. 1009 ¶ 8; Ex. 1003 ¶ 90).

Dr. Josefowicz opines that tensile strength would have affected both the handleability of copper foil as well as the formation of wrinkles and other surface defects. Pet. 27. According to Dr. Josefowicz, "[t]he implication of the increase in tensile strength … is the significant improvement of its handleability and resistance to plastic deformation under low to medium load conditions. Indeed, fewer wrinkles and other surface defects are being reported by several users of the foil." *Id.* (quoting Ex. 1003 ¶91 (citing Ex. 1014, 2)).

b. Claim 2

Claim 2 depends from claim 1 and recites "wherein the copper foil has a surface roughness (R_z-JIS) of 2 μm or less." Ex. 1001, col. 6, ll. 48–50.

Petitioner argues that Kim teaches that its copper foil has a surface roughness R_z of approximately 0.050 μm, which falls within the claimed range of "2 μm or less." Pet. 28 (citing Ex. 1018, Figs. 2–4, and Table 1).

Petitioner also points to Hara's teaching of R_z values that fall within the claimed range, along with associated advantages that would have motivated a skilled artisan to apply Hara's teachings to Kim's copper foil. Pet. 29. Specifically, Petitioner contends, Hara explains that "it is preferable that the negative electrode current collector has … a surface roughness R_z of 2.0 μm or less" and that "by using electrolytic copper foil with … a surface roughness of R_z of 2.0 μm or less in the negative electrode current collector, a battery with excellent cycle life characteristics can be realized." *Id.* (quoting Ex. 1009 ¶¶ 13, 51). Petitioner argues that Hara also discloses examples such as "surface roughness R_z (a ten-point average surface roughness) = 1.5 μm" and cites to a JIS standard. *Id.* at 29–30 (quoting Ex. 1009 ¶¶ 31, 35; Ex. 1003 ¶ 149).

Petitioner also contends that a person of ordinary skill in the art would have found it obvious to apply Otsuka's teachings of R_z values to Kim's copper foil. Pet. 30. Specifically, argues Petitioner, Otsuka teaches or suggests that "[t]he electrodeposited copper foil has a surface roughness R_z at a deposition surface at ordinary temperature smaller than 2.5 μm in terms of 10-point average roughness R_z." *Id.* (citing Ex. 1010, Abstr., claim 1 ¶¶ 14, 20, 25, 26).

Petitioner also points to the testimony of Dr. Josefowicz, who opines that it was common and perhaps conventional knowledge in the art that copper foil with a "surface roughness (R_z-JIS) of 2 μm or less" would be effective for adhesion between the current collector and the active material. Pet. 30. Dr. Josefowicz notes that numerous prior art references teach R_z values of copper foil that anticipate the claimed range of "2.0 μm or less," specifically for use in current collectors of secondary batteries. *Id.* (citing Ex. 1003 ¶ 99 (citing Ex. 1011 ¶¶ 12, 29; Ex. 1017, Abstr., 4, 5; Ex. 1022 ¶¶ 18, 57, 107; Ex. 1023, Abstr., ¶ 12)).

c. Claim 3

Claim 3 depends from claim 1 and recites "wherein the copper foil has an elongation of 3 to 20%." Ex. 1001, col. 6, ll. 51–53.

Petitioner argues that Hara teaches an elongation rate of 5% or less, provides examples, such as 4.8%, and describes advantages of such elongation rates including the realization of excellent cycle life characteristics of a battery. Pet. 31 (citing Ex. 1009 ¶ 50; Ex. 1003 ¶ 100). Petitioner asserts that the elongation values of Hara applied to Kim's copper foil in the combination fall within the claimed range of 3 to 20%. *Id.* (citing Ex. 1003 ¶ 101).

d. Claim 4

Claim 4 also depends from claim 1 and recites "foil has a thickness of 1 to 35 μm." Ex. 1001, col. 6, ll. 54–56.

Petitioner argues that Kim teaches that the copper foil used in its study is "8 μm thick." Pet. 31 (citing Ex. 1018, Abstr., 155; Ex. 1003 ¶ 102).

Petitioner additionally argues that Hara describes thickness values for its copper foil that fall within the claimed range, along with associated advantages that would have motivated a person of ordinary skill in the art to apply Hara's teachings to Kim's copper foil. Pet. 32. Specifically, Petitioner contends that Hara teaches that "it is preferable that the negative electrode current collector has a thickness of 7 μm to 25 μm and a surface roughness R_z of 2.0 μm or less." *Id.* (citing Ex. 1009 ¶ 13). By way of example, Petitioner contends Hara describes that "in Examples 4–7, batteries were fabricated in the same manner as in Example 3, except that electrolytic copper foils with thicknesses of 10, 15, 20, and 25 μm, respectively, and elongations of 3.5, 2.5, 2.2, and 2.0%, respectively, were used for the negative electrode current collector." *Id.* (citing Ex. 1009 ¶ 33). Petitioner notes that Hara additionally teaches that the advantages of such thickness values include realization of excellent cycle life characteristics of a battery. *Id.* (citing Ex. 1009 ¶ 51). Petitioner argues that a skilled artisan would have found it obvious to apply Hara's teachings of thickness values to Kim's copper foil. *Id.* (citing Ex. 1003 ¶ 104).

6. Patent Owner's Preliminary Response

Patent Owner responds that Petitioner fails to articulate a sufficient motivation to combine the references for any of the Grounds, and also fails to articulate a reasonable expectation of success in combining the cited references to arrive at Patent Owner's claimed invention. Prelim. Resp. 32–33. Patent Owner asserts that Petitioner relies on conclusory reasoning for why a person of ordinary skill would have reasonably expected success in combining very different foil properties from three or more references to arrive at what is claimed. *Id.* at 33. Patent Owner argues that Petitioner's cited art demonstrates that a skilled artisan would not have simply expected success in combining the properties taught by the various references. *Id.*

Patent Owner argues that Petitioner allegedly cherry-picks foil properties from Kim, Hara, and Otsuka, and argues that a combination of these properties would have been obvious. Prelim. Resp. 34 (citing Pet. 11–17; Ex. 1003 ¶¶ 52–64). In particular, Patent Owner asserts that Petitioner relies on Kim as teaching the claimed texture coefficient ratios, but recognizes that Kim does not disclose: (1) the weight deviation range; or (2) the tensile strength range recited in challenged claim 1, and relies on Hara and Otsuka as teaching these limitations, respectively. *Id.* at 34–35 (citing Pet. 17–24; Ex. 1003 ¶¶ 66–71, 75–85).

Patent Owner contends that Petitioner's arguments assume that the different foil properties selected from each reference are interchangeable. Prelim. Resp. 35. However, Patent Owner argues, Petitioner does not substantiate a reasonable expectation that the foil properties chosen from the different references could be predictably combined to arrive at the claimed invention. *Id.* at 35–36. Rather, argues Patent Owner, Petitioner asserts that a skilled artisan would have had a reasonable expectation of success because each reference discloses similar process parameters for making an electrolytic copper foil. *Id.* at 36 (citing, e.g., Pet. 15–16).

Particularly with respect to Hara, Patent Owner argues that Petitioner also surmises that a person of ordinary skill "would have known that electrolytic copper foils with weight deviation in the claimed range were commercially available and therefore would have recognized the ease of applying such teachings." Prelim. Resp. 36 (quoting Pet. 15). Summarizing, Patent Owner maintains that Petitioner essentially argues that because each reference discloses electroplated copper foils, there would have been a reasonable expectation of success in combining them. *Id.*

According to Patent Owner, Petitioner merely asserts a reasonable expectation of success, without performing the requisite analysis. Prelim. Resp. 37. Patent Owner asserts that Petitioner makes no comparison between the processing conditions and parameters from the different references, nor does Petitioner explain why the foil properties from one reference would be compatible with the properties from another reference. *Id.* For example, argues Patent Owner, Petitioner surmises that "it was conventional to vary the electrolyte concentration, electrolysis plating parameters, temperature, and the use of organic and inorganic additives, in order to obtain a copper foil with tensile strength," as claimed. *Id.* (quoting Pet. 16). However, Patent Owner argues, Petitioner's statement that there is some overlap in process conditions alone does not support its assertion that properties of foils from three different references could be predictably combined with a reasonable expectation of success. *Id.*

Patent Owner contends that, with respect to the limitation reciting the claimed range of tensile strength, Exhibit 1025's Table 2, cited in the Petition, actually contradicts Petitioner's argument. Prelim. Resp. 37 (citing Pet. 16). Patent Owner's annotated version of Table 2 is reproduced below:

Table 2. PROPERTIES OF COPPER ELECTRODEPOSITS USEFUL FOR DIVERSE APPLICATIONS

Outstanding Characteristic	Tensile Strength, kg/mm^2	Elongation, % (5cm)	Internal Stress,[c] kg/mm^2	Hardness (VHN$_{200}$), kg/mm^2	Electrical Resistivity, michrohm-cm
High strength	45–63.5	4–18	−4.2 or 3.6 to 5.5	131–159	1.75–2.02
Hardness	3.5–55.5	0–10	−4.2 or 3.0	193–350	1.96–4.60
Low electrical resistivity	18.5–27	15–41	−0.5 to −1.6	48–64	1.70–1.73
Near zero stress	14–16	8–24	−0.08–0.06	56–57	1.71–1.72
Good leveling	36–36.5	14–19	2.0	128–137	1.82
Thermal stability[b]	22.5–30	26–39	0.5–2.9	55–106	1.73–1.76

[a]Negative values indicate a compressive stress.
[b]Deposits that changed less than 0.02% in length after heating to 400°C.

197

According to Patent Owner, Table 2 shows that varying process conditions and parameters can result in tensile strengths ranging from of 45 to 63.5 kgf/mm^2, at least 12.5% greater than 40 kgf/mm^2, the upper end of the claimed range. Prelim. Resp. 37–38.

Moreover, argues Patent Owner, with respect to weight deviation, Petitioner states that "it would have been obvious to a POSITA to use an electrolytic copper foil with minimal weight variance across the foil, but that such recognition likely was not expressly stated due to the overwhelming obviousness of the fact." Prelim. Resp. 38 (quoting Pet. 15). Patent Owner asserts that Petitioner does not explain why the process conditions that achieve the crystal structure ratios and tensile strength in other cited references would have reasonably been expected to achieve a weight deviation of 3% or less, as recited in challenged claim 1. *Id.* Patent Owner points out that Hara (the reference relied on by Petitioner as disclosing the recited weight deviation) does not support Petitioner's argument because Hara is silent with respect to anything concerning the electrolytic process conditions for making a copper foil. *Id.*

Patent Owner asserts that the fact the references disclose electroplated copper foils does not establish that there would have been a reasonable expectation of success in combining foil properties from three different references to arrive at the claimed invention. Prelim. Resp. 39. Patent Owner alleges that Petitioner's failure to present a reasonable expectation of success, beyond the simple assertion that the references relate to electroplated copper foils, is fatal to its challenge to claims 1–4 on all Grounds. *Id.*

Patent Owner next asserts that Petitioner's arguments assume that a person of ordinary skill in the art would have recognized that all foil properties (specific texture coefficient ratios, weight deviation, and tensile strength) are relevant properties for electrolytic copper foils designed for the different end-use applications taught by Kim (PCBs) and Hara and Otsuka (batteries), and that properties from materially different foils can be combined with each other. Prelim. Resp. 39. According to Patent Owner, Petitioner provides no support for this assumption, or any evidentiary support for arguing that crystal structure ratios and physical foil properties from at least three different references could be predictably combined. *Id.* at 40.

By way of example, Patent Owner points to the testimony of Dr. Josefowicz, who, Patent Owner alleges, does not explain how a skilled artisan would have adjusted any of numerous process conditions (e.g., additive concentrations, solution chemistry, treatment time, current density, etc.) to arrive at a copper foil with the claimed properties. Prelim. Resp. 40. Patent Owner asserts that the silence of both Petitioner and Dr. Josefowicz upon this point requires denial of the Petition. *Id.* (citing *Juniper Networks,* *Inc. v. Correct Transmission, LLC*, IPR2021-00682, Paper 26 at 24 (PTAB Oct. 3, 2022) (holding that "Petitioner does not explain sufficiently why such contentions (and any underlying cited evidence), even if undisputed, show that the skilled artisan would have had a reasonable expectation of success")).

Patent Owner contends that, at most, Petitioner's arguments amount to the proposition that a person of ordinary skill in the art would have varied the variety of different process parameters and conditions until a copper foil with the claimed properties resulted. Prelim. Resp. 40. Patent Owner asserts that this falls short of establishing the requisite reasonable expectation of success. *Id.* at 40–41 (citing *Medichem, S.A. v. Rolabo, S.L.*, 437 F.3d 1157, 1165 (Fed. Cir. 2006)).

Patent Owner argues that Petitioner fails to substantiate its proposition that a skilled artisan would have been motivated to combine Kim and the secondary references while maintaining the same texture coefficient values (and therefore, the same ratios) disclosed by the isolated example in Kim. Prelim. Resp. 41. Patent Owner points out that Kim does not teach or otherwise recognize the significance of the claimed texture coefficient ratios, and that a person of ordinary skill in the art would therefore have had no reason to try to retain the same texture coefficient ratios, let alone expect that doing so would help prevent wrinkles in the copper foil. *Id.* (citing *Par Pharm., Inc. v. TWi Pharms. Inc.*, 773 F.3d 1186, 1195 (Fed. Cir. 2014)).

Finally, Patent Owner argues that Hara and Otsuka disclose conflicting copper foil elongation rates and thicknesses. Prelim. Resp. 46. According to Patent Owner, Hara teaches that copper foils having a weight variation of 2% or less should also be selected to have an elongation rate of

5% or less and a thickness ranging from 7 to 25 μm. *Id.* (citing Ex. 1009 ¶¶ 11–13). In contrast, Patent Owner argues, Otsuka teaches that copper foils having a tensile strength of no more than 40 kgf/mm^2 should have an elongation rate of at least 14% and a thickness of 35 microns. *Id.* at 46–47 (citing Ex. 1010 ¶¶ 22, 32, 46).

Patent Owner asserts that Petitioner provides no explanation as to why the cited weight deviation value from Hara's relatively rigid and thin foils is compatible with the tensile strength range from Otsuka's thicker and more flexible foils. Prelim. Resp. 47. According to Patent Owner, the cited prior art teaches that the weight deviation and tensile strength would not have been predictably combined because Hara and Otsuka disclose very different foils. *Id.* Patent Owner asserts that Petitioner does not address the conflicting differences between Hara's and Otsuka's elongation rate and foil thicknesses when arguing that there would have been a reasonable expectation of success in combining these two references. *Id.* Patent Owner argues that this discrepancy is relevant because Petitioner modifies Kim in view of *both* Hara and Otsuka. *Id.* Patent Owner also contends that Petitioner does not offer any evidence or rationale to establish why Hara and Otsuka would have directed a skilled artisan to a copper foil having the claimed texture coefficient ratios, weight deviation, and tensile strength with a reasonable expectation of success. Id. at 47–48.

7. Analysis

The burden of proving the unpatentability of the challenged claims rests with (and is borne at all times by) Petitioner. 35 U.S.C. §§ 314(a), 316(e); *see also In re Magnum Oil Tools Int'l, Ltd.*, 829 F.3d 1364, 1375

(Fed. Cir. 2016). To satisfy this burden, Petitioner must "articulate specific reasoning, based on evidence of record, to support the legal conclusion of obviousness"; "mere conclusory statements" will not suffice. *Magnum Tools*, 829 F.3d at 1380. Indeed, "[i]t is of the utmost importance that petitioners in the IPR proceedings adhere to the requirement that the initial petition identify 'with particularity' the 'evidence that supports the grounds for the challenge to each claim.'" *Intelligent Bio-Sys., Inc. v. Illumina Cambridge Ltd.*, 821 F.3d 1359, 1369 (Fed. Cir. 2016) (quoting 35 U.S.C. § 312(a)(3)).

Furthermore, "[a]n obviousness determination requires finding that a person of ordinary skill in the art would have been motivated to combine or modify the teachings in the prior art and would have had a reasonable expectation of success in doing so." *See Regents of the Univ. of Cal. v. Broad Inst., Inc.*, 903 F.3d 1286, 1291 (Fed. Cir. 2018). We have consistently denied institution of *inter partes* review in cases in which the petitioner fails to meet its burden of demonstrating a reasonable likelihood of success at trial with respect to the latter requirement. *See NJOY, LLC v. JUUL Labs., Inc.*, IPR2024-00536, Paper 17 (PTAB Aug. 12, 2024) (denying institution where petitioner did not show a reasonable expectation of success in combining the asserted references); *see also Honeywell Int'l Inc. v. DSM IP Assets, B.V.*, IPR2024-00493, Paper 7 (PTAB Aug. 21, 2024).

We conclude that, in this instance, Petitioner fails to meet its burden of showing that a person of ordinary skill in the art would have had a reasonable expectation of success in combining the references.

Kim teaches an electroplated copper film (the term "foil" is never used in Kim[11]) for use on a flexible PCB ("FPCB"). Ex. 1018, 154. Specifically, Kim teaches that, in depositing the copper onto the FPCB:

> A polyimide film (Dupont) coated with sputtered copper as thick as 2000 Å was used as a cathode electrode. A phosphorized copper plate (containing 0.05% phosphorus) was used as an anode electrode. The basic electrolyte was composed of 72 g/L $CuSO_4 \cdot 5H_2O$, 180 g/L H_2SO_4 and 30 ppm Cl^-. The electrolyte temperature was kept constant at 25±1°C. Electroplating was carried out in a stagnant solution under the constant current of 13 mA/cm^2 until the copper film approached to 8 μm thick.

Id. at 155.

In other words, Kim teaches that its copper foil is sputter coated[12] (essentially, electrically sprayed at an atomic level) onto a polyimide substrate, and then electroplated with more copper to provide a smooth surface. Kim teaches that when the sputter-coated film is being

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[11] Because the issue of whether Kim's "film" constitutes a "foil," as that term is understood in the art, is not dispositive of the issue in this Decision, we do not reach the issue of how to construe the claim term "foil."

[12] Sputter coating is:

> A physical vapor deposition process used to apply a very thin, functional coating onto a substrate. The process starts by electrically charging a sputtering cathode which in turn forms a plasma causing material to be ejected from the target surface.… The high energy target material impacts the substrate and is driven into the surface of the substrate forming a very strong bond at an atomic level. This material is now a permanent part of the substrate rather than an applied coating or plating of the surface.

Sputter Coating - Sputter Deposition, *available at*: https://angstromsciences.com/sputter-coating (last visited May 9, 2025).

electroplated, the addition of organic compounds, mainly accelerators, inhibitors, and/or levelers added to the basic electrolyte solution can affect the residual stress and surface roughness of the electroplated copper film.

Specifically, and relevantly, Kim teaches that one combination of accelerator, leveler, and inhibitor (i.e., basic solution [described in the preceding quoted passage] + 300 ppm inhibitor + 20 ppm leveler + 5 ppm accelerator) can produce a film with a surface roughness (R_z) of about 40 nm. Ex. 1018, Figs. 2–4. Table 1 of Kim also provides data showing the peak amplitude of XRD in the (111), (200), and (220) preferred planes can, when compared as the ratios recited in limitations 1[a] and 1[b] of challenged claim 1 of the '541 patent, fall within the ranges recited in the claim. Table 1 of Kim is reproduced again:

Table 1. Relation between residual stress and preferred plane formed during plating (I: inhibitor, L: leveler, A: accelerator).

Electrolyte	Texture coefficient			Residual stress (MPa)	Preferred plane
	(111)	(200)	(220)		
300ppm I + 20ppm L	0.23	0.30	**2.47**	6.92	(220)
300ppm I + 20ppm L + 5ppm A	0.88	**1.15**	0.97	0	(200)

By contrast, both Hara and Otsuka teach the use of conventional, electroplated copper foils for use as current collectors in secondary lithium batteries, although they each teach different synthetic steps. Specifically, Hara teaches, with respect to its anode:

> To the 92 parts by weight of Carbotron P powder manufactured by Kureha Co., Ltd., which is an amorphous carbon, as a carbon material of active material, 8 parts by weight of polyvinylidene fluoride was added as a bonding agent to make a negative electrode mixture, and N-methyl-2-pyrrolidone, a dispersion solvent, was added to this, and kneading was performed to obtain a slurry. This slurry is applied to both sides of the electrolytic copper foil (negative electrode current collector) of a predetermined thickness with a weight variation of 2% or less per unit area, dried, and pressed at a predetermined pressure using a

> roll press machine set to a surface temperature of 120°C to form a negative electrode mixture layer, and cut to obtain a negative electrode having a width of 305 mm, a predetermined length, a predetermined bulk density, and a negative electrode mixture layer (active material coated portion) of a predetermined thickness (not including the thickness of the current collector).

Ex. 1009 ¶ 16.

We note that Hara is silent with respect to the origins or synthesis of its electrolytic copper foil, except to note that "the negative electrode current collector is characterized by an electrolytic copper foil having a weight variation of 2% or less per unit area and an elongation of 5% or less before pressing the negative electrode mixture layer to a predetermined bulk density." Ex. 1009 ¶ 11. Hara also teaches that "it is preferable that the negative electrode current collector has a thickness of 7 µm to 25 µm and a surface roughness R_Z of 2.0 µm or less." *Id.* ¶ 13.

Otsuka describes the electroplating process used to produce electroplated copper foils in its Examples 1–3. Ex. 1010 ¶¶ 35–42. Otsuka is similarly obscure when it comes to origin of the base substrate (presumably a rolled copper foil, *see id.* ¶¶ 30–31) that is electroplated by the methods described in Examples 1–3. Otsuka reports that the electrodeposited copper foils of its Examples 1–3, having thicknesses of 35 m had tensile strengths of 32, 38, and 36 kgf/mm^2, respectively. *Id.* ¶¶ 35–36, Table 1.

Dr, Josefowicz, notes that copper foils intended for different uses are essentially interchangeable:

> Kim discloses copper foil for use in PCB, which is also compatible for use with secondary batteries. Such use compatibility of electrolytic copper foil between PCBs and the secondary batteries was well-known at the time. Accordingly, a

> POSITA would have easily recognized such use compatibility of electrolytic copper foil, which is also evidenced by prior art.

Ex. 1003 ¶ 55. As evidence of this, Dr. Josefowicz points to Dobashi,[13] and Sano.[14] *Id.*

Sano teaches that its electrodeposited copper foil with low roughness surface is applicable "in printed-wiring boards or cathode collectors of lithium secondary battery." Ex. 1023 ¶ 12. Dobashi teaches, e.g., that its surface-treated, electro-deposited copper foil has numerous uses, including the formation of fine-pitch wiring or a chip on film substrate, electromagnetic wave shield patterns in plasma display panels, as material for forming the bottom electrode of the embedded capacitor of a printed wiring board with embedded capacitor, and as the negative electrode current collector of a lithium ion secondary battery. Ex. 1022 ¶ 107.

However, none of Kim, Hara, Otsuka, Sano, or Dobashi indicate that the sputter-coated, electroplated, polyimide substrate copper film of Kim could be reasonably combined with the more conventional, but differently produced, electroplated foils of Hara or Otsuka to arrive at a foil having the crystal structure of Kim's foil, as well as the claimed "weight deviation of 3% or less," and the "tensile strength of 30 to 40 kgf/mm^2" recited in challenged claim 1.

Furthermore, we are skeptical of whether a copper film, sputter-deposited and electrodeposited onto a polyimide substrate, as taught by Kim, could be productively used as a current collector in a secondary lithium

[13] Dobashi et al., (US 2009/0047539 A1, February 19, 2009) ("Dobashi") Ex. 1022.

[14] Sano et al., (US 2006/0191798 A1, August 31, 2006) ("Sano") Ex. 1023.

battery, which is the use envisioned for their respective foils by Hara and Otsuka, and as recited in the claims.

Dr. Josefowicz testifies that electrodeposited foils with the weight variation taught by Hara were "generally and commercially available" and that "it was conventional to vary the electrolyte concentration, electrolysis plating parameters, temperature, and the use of organic and inorganic additives, in order to obtain a copper foil with tensile strength and elongation values falling within the claimed ranges." Ex. 1003 ¶¶ 62–63. But Dr. Josefowicz adduces no supporting evidence that the different methods used to produce Kim's electrodeposited film, or to electroplate Hara's or Otsuka's electrodeposited foils, were interchangeable such that one could provide the differing methods by which film and/or foil are produced and obtain a copper foil with all of the properties recited in challenged claim 1 of the '541 patent.

Dr. Josefowicz attests further that:

> [T]he optimization of weight deviation, elongation, and tensile strength values in copper foil 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 and other plating parameters such as solution agitation and temperature.

Ex. 1003 ¶ 63 (citing Ex. 1025, Table 2).

However, we find this testimony to be conclusory in nature and largely unsupported by evidence that a person of ordinary skill in the art could successfully combine the specific film and methods of Kim with the specific methods and electrodeposited foils of Hara and Otsuka to achieve the invention recited in challenged claim 1 with a reasonable expectation of success. Indeed, although each property may be desirable and separately optimized *via* varying one or more process parameters, Petitioner has not shown a reasonable expectation of success that *all* of the recited properties, including the particular crystal structure, as well as weight deviation, elongation, and tensile strength, would have been reasonably expected to be achieved in a single product without the hindsight of the ’541 patent. Accordingly, we conclude that Petitioner fails to meet its burden of showing a reasonable likelihood of that challenged claim 1 would have been obvious over the combination of Kim, Hara, and Otsuka. For the same reasons, we are not persuaded by Petitioner’s arguments with respect to claims 2–4 of the ’541 patent.

D. Ground 2: Alleged Obviousness of Claims 1–4 over Ye, Hara, and Otsuka

1. Overview of Ye

Ye is an article entitled *Role of Overpotential on Texture, Morphology and Ductility of Electrodeposited Copper Foils for Printed Circuit Board Applications*, published in the Journal of the Electrochemical Society in June, 1992. Ex. 1013. Ye is directed to “[a] study … to correlate different electrodeposition parameters, like, e.g., cathodic overpotential, bath composition, and bath ageing, with characteristics such as crystallographic texture and roughness, and the ductility of electrolytic copper foils. *Id.* at Abstr.

Ye teaches that copper foils of about 20 μm in thickness were “aged” for either 3 or 12 hours in a solution of “0.36M $CuSO_4 \cdot 5H_2O$ and 2.04M H_2SO_4 … [with s]odium chloride … as an additive.” Ex. 1013, 1593. Ye electroplated a total of 44 foils under various electrodeposition conditions such as overpotential, current density, chloride ion concentration, pretreatment methods, morphology, aging time (3 or 12 hours), and penetration depth. *Id.* at 1593–1594, Table I. The measured and normalized peak amplitudes of the XRD peaks of each of the (111), (200), and (220) preferred planes were set forth in Table II, which is reproduced below:

Table II. Relative peak intensity, corresponding NPI and stress ratio (ρ^*) for specimens tested.

No.	(111) Measured	(200) Measured	(220) Measured	(111) Normalized	(200) Normalized	(220) Normalized	ρ^*
Random	100.0	49.5	12.0	33.3	33.3	33.3	
1	100.0	44.4	86.7	11.0	9.8	79.2	
2	100.0	31.6	16.5	33.2	21.2	45.5	
3	100.0	45.5	69.7	12.9	11.9	75.2	
4	100.0	28.8	16.4	33.9	19.7	46.4	
5	100.0	35.9	53.8	16.1	11.7	72.2	
6	100.0	34.0	28.3	24.7	17.0	58.3	
7	100.0	33.7	15.4	33.8	23.0	43.3	
8	100.0	23.6	27.0	26.9	12.8	60.3	
9	100.0	31.0	71.4	13.2	8.3	78.6	
10	100.0	22.2	22.2	30.3	13.6	56.1	
11	100.0	29.4	88.2	11.2	6.6	82.2	
12	100.0	24.1	53.4	16.8	8.2	75.0	
13	100.0	33.3	18.5	31.1	20.9	48.0	
14	100.0	46.3	10.4	35.7	33.4	30.9	
15	100.0	52.6	21.1	26.2	27.9	46.0	
16	100.0	25.5	30.0	24.9	12.8	62.3	
17	100.0	41.0	43.6	18.3	15.2	66.5	
18	98.1	50.0	100.0	9.5	9.8	80.7	
19	100.0	29.2	18.5	32.0	18.9	49.2	
20	100.0	31.3	31.3	23.6	14.9	61.5	
21	81.5	48.1	100.0	8.1	9.6	82.3	
22	100.0	32.7	34.6	22.0	14.5	63.5	
23	67.5	32.5	100.0	7.0	6.8	86.2	
24	70.6	41.2	100.0	7.2	8.4	84.4	
25	100.0	40.5	94.6	10.3	8.4	81.3	
26	100.0	13.8	13.8	41.1	11.5	47.4	
27	100.0	28.9	75.6	12.7	7.4	79.9	
28	100.0	26.6	18.1	32.8	17.6	49.5	
29	100.0	27.5	75.0	12.8	7.1	80.1	
30	100.0	26.4	18.4	32.6	17.4	50.0	
31	84.6	34.6	100.0	8.6	7.1	84.4	
32	100.0	30.0	15.0	35.0	21.2	43.8	
33	100.0	25.5	12.7	38.8	20.0	41.2	
34	100.0	24.6	11.4	40.9	20.3	38.8	
35	9.4	4.7	100.0	1.1	1.1	97.8	1.047
36	29.2	8.3	100.0	3.3	1.9	94.8	1.053
37	100.0	25.7	42.9	19.6	10.2	70.2	
38	100.0	25.0	83.3	11.8	6.0	82.2	1.072
39	16.4	5.5	100.0	1.9	1.3	96.8	
40	4.1	2.1	100.0	0.5	0.5	99.0	1.033
41	100.0	21.7	10.0	44.0	19.3	36.7	1.089
42	100.0	28.7	20.4	30.5	17.7	51.8	
43	100.0	32.6	16.3	33.2	21.8	45.0	
44	5.5	2.7	100.0	0.6	0.7	98.7	

2. Petitioner's arguments

Petitioner points to sample 15 of Ye, which, it argues, satisfies the requirements of limitations [1a]–[1b] of claim 1 of the '541 patent. Petitioner argues that it would have been obvious to a person of ordinary skill in the art to have combined Ye with Hara and Otsuka, especially because the prior art provides sufficient motivation and guidance for modifying Ye's copper foil to obtain the desired the texture coefficients while taking advantage of Hara's disclosed weight deviation of ≤ 2%, $R_z \leq 2$ μm, and elongation ≤ 5% and Otsuka's disclosed tensile strength ≤ 40 kgf/mm^2. Pet. 35 (citing Ex. 1003 ¶ 114). Petitioner's arguments are similar to those it advanced with respect to Ground 1, and will be briefly summarized.

Petitioner first notes that Ye discloses copper foil for use in PCB, which is also compatible for use with secondary batteries as, Petitioner contends was well-known in the art. Pet. 35 (citing Ex. 1022 ¶ 107; Ex. 1023 ¶¶ 1, 5, 12, 66; Ex. 1012 ¶ 10, 12, 52; Ex. 1003 ¶ 115).

Petitioner argues that a person of ordinary skill in the art, seeking to utilize or optimize Ye's electrolytic copper foil for use in secondary batteries, would have looked at other references, including Hara and Otsuka, and would have recognized that factors such as weight deviation, elongation, tensile strength, and R_z values are important for further optimizing Ye's electrolytic copper foil for use in secondary batteries. Pet. 35–37 (citing Ex. 1003 ¶ 116).

Petitioner also argues that a person of ordinary skill in the art would have had a reasonable expectation of success in combining the references for several reasons. Pet. 37. First, Petitioner argues, because both Hara and Otsuka focus on providing electrolytic copper foil for use in lithium-ion secondary batteries and the use compatibility of electrolytic copper foil between PCBs and secondary batteries was well known, a skilled artisan would have expected success in applying the teachings of weight deviation, elongation, tensile strength, and R_z values of Hara and Otsuka. *Id.* (citing Ex. 1003 ¶ 121).

Petitioner argues further that the fact that electrolytic copper foils with a given weight deviation range were commercially available suggests that a skilled artisan would have recognized the alleged ease of applying such teachings, or otherwise would have been familiar with the recipes or methods to produce copper foils with the desired weight deviation characteristics. Pet, 37 (citing Ex. 1003 ¶ 122).

Finally, argues Petitioner, and as with Ground 1, the optimization of weight deviation, elongation, tensile strength, and R_z values in copper foil would have involved no more than mere routine optimization of electrodeposition conditions. Pet. 37 (citing Ex. 1003 ¶ 123).

3. Patent Owner's Preliminary Response

Patent Owner repeats many of its arguments presented with respect to Petitioner's proposed combination of Kim, Hara, and Otsuka presented in Section III.C. 6 above. Additionally, Patent Owner argues that the vast majority of Ye's examples that fail to meet the claimed texture coefficient ratio ranges show that texture coefficient ratios and physical properties such as tensile strength are not predictably compatible. Prelim. Resp. 41.

Patent Owner notes that Petitioner has cited to, and selected, only a single example of the 44 represented in Ye's Tables I and II. Prelim. Resp. 41. The reason for this, Patent Owner alleges, is that sample 15 is the only specimen for which Petitioner could derive texture coefficient ratios that allegedly satisfy the requirements of challenged claim 1. *Id.* at 41–42.

Patent Owner represents that it has derived texture coefficient ratios for all 44 specimens in Ye using the same methodology used by Petitioner and Dr. Josefowicz. Prelim. Resp. 42. Patent Owner's Table A, which is reproduced below, shows the derived ratios for each specimen:

	TC (111) + TC (200) ratio	**TC (111) ratio**	**TC (200) ratio**	**TC (220) ratio**
Claim 1	0.60 to 0.85	0.18 to 0.38	0.28 to 0.62	0.15 to 0.40
Specimens from Ye				
1	0.312	0.159	0.153	0.688
2	0.672	0.398	0.273	0.328
3	0.363	0.183	0.181	0.637
4	0.665	0.409	0.256	0.335
5	0.398	0.224	0.175	0.602
6	0.551	0.317	0.234	0.449
7	0.692	0.400	0.293	0.308
8	0.528	0.349	0.179	0.472
9	0.319	0.191	0.129	0.681
10	0.572	0.386	0.186	0.428
11	0.271	0.165	0.106	0.729
12	0.363	0.238	0.125	0.637
13	0.651	0.378	0.273	0.349
14	0.794	0.396	0.398	0.206
15	0.670	0.313	0.358	0.330
16	0.509	0.327	0.181	0.491
17	0.465	0.246	0.219	0.535
18	0.293	0.139	0.154	0.707
19	0.639	0.391	0.248	0.361
20	0.518	0.308	0.210	0.482
21	0.271	0.119	0.152	0.729
22	0.497	0.291	0.207	0.503
23	0.216	0.106	0.111	0.784
24	0.243	0.107	0.136	0.757
25	0.284	0.151	0.133	0.716
26	0.653	0.503	0.151	0.347
27	0.301	0.185	0.116	0.699
28	0.636	0.403	0.233	0.364
29	0.299	0.187	0.112	0.701
30	0.631	0.401	0.230	0.369
31	0.242	0.128	0.114	0.758
32	0.688	0.416	0.271	0.312
33	0.710	0.457	0.253	0.290
34	0.729	0.475	0.254	0.271
35	0.038	0.018	0.020	0.962
36	0.086	0.053	0.033	0.914
37	0.421	0.270	0.151	0.579
38	0.270	0.175	0.095	0.730
39	0.054	0.031	0.023	0.946
40	0.017	0.008	0.009	0.983
41	0.746	0.507	0.239	0.254
42	0.614	0.378	0.236	0.386
43	0.677	0.396	0.281	0.323
44	0.022	0.011	0.011	0.978

Id. at 42–43.

Patent Owner states, with respect to Table A, that the TC ratios highlighted in orange satisfy the claimed range, and that TC ratios not highlighted fall outside the claimed range. Prelim. Resp. 42. Patent Owner contends that all of the specimens except for sample 15 (highlighted darker orange) have at least one texture coefficient ratio that falls outside the range recited in challenged claim 1 of the ’541 patent. *Id.*

According to Patent Owner, the data presented in Ye’s Table II, and the processing conditions summarized in Ye’s Table I, demonstrate that “the crystallographic texture of metal deposits depends on the processing parameters, such as bath composition, pH, overpotential, deposition rate (current density), substrate, mass-transport condition, etc.” Prelim Resp. 43 (citing Ex. 1013, 1594). Patent Owner argues that Ye’s data is consistent with the data in Kim’s Table 1 (which is reproduced below), showing that the addition of 5 ppm of an accelerator had a noticeable effect on crystal plane texture coefficients. *Id.* at 43–44.

Table 1. Relation between residual stress and preferred plane formed during plating (I: inhibitor, L: leveler, A: accelerator).

Electrolyte	Texture coefficient			Residual stress (MPa)	Preferred plane
	(111)	(200)	(220)		
300ppm I + 20ppm L	0.23	0.30	**2.47**	6.92	(220)
300ppm I + 20ppm L + 5ppm A	0.88	**1.15**	0.97	0	(200)

Patent Owner notes that Ye explains that crystal grain size of the electrolytic copper foils is also noticeably affected by electroplating conditions. Prelim. Resp. 44 (citing Ex. 1013, 1597–98). By way of example, Patent Owner points to Ye’s statement that “at an overpotential of 113 mV a grain size of 2 μm is noticed (specimen No. 17) [but] at an overpotential of 250 mV the grain size was 1 μm (specimen No. 32) (Fig. 12).” *Id.* (quoting Ex. 1013, 1597).

Patent Owner suggests that Petitioner ignores Ye's teachings about how processing conditions affect crystal texture and grain size, Petitioner makes the conclusory argument that a person of ordinary skill in the art would reasonably have expected that applying Otsuka's processing techniques to Ye would create a foil having a tensile strength of 30 to 40 kgf/mm^2, while also retaining the specific texture coefficient ratios disclosed in isolated examples from Ye. Prelim. Resp. 44. Patent Owner asserts that this proposition is not supported by the cited art. *Id.*

Patent Owner further observes that Otsuka specifies that the copper foils must have "an extremely fine crystal structure, so the copper foil itself is soft" to achieve the desired tensile strength. Prelim. Resp. 44 (quoting Ex. 1010 ¶ 29). Patent Owner points to the treated copper foils of Otsuka's Examples 1–3, which yield a tensile strength between 30 to 40 kgf/mm^2, and in which the foil "had fine crystal structures at ordinary temperature yet had ordinary temperature tensile strengths of not more than 40 kg/mm^2." *Id.* at 45 (quoting Ex. 1010 ¶ 46).

Patent Owner further points out that Otsuka quantifies the required "fine crystal structures" as a lack of fine crystal grains of "an average particle size of several tenths of a micron … at the deposition surface" of the copper foil. Prelim. Resp. 45 (quoting Ex. 1010 ¶¶ 26, 28, 47) (alteration in original).

Patent Owner asserts that this interplay between crystal structure texture coefficients, crystal structure grain size, and tensile strength is overlooked by Petitioner and Dr. Josefowicz. Prelim. Resp. 45. Patent Owner argues that Petitioner's own art explains that these foil properties cannot be simply mixed and matched to achieve a desired foil. *Id.* To the contrary, Patent Owner contends, Ye in particular evidences that texture coefficients and grain size cannot be simply combined. *Id.* Patent Owner points to its Table B, which is extracted from Table A above, and is reproduced below:

	TC (111) + TC (200) ratio	**TC (111) ratio**	**TC (200) ratio**	**TC (220) ratio**
Claim 1	0.60 to 0.85	0.18 to 0.38	0.28 to 0.62	0.15 to 0.40
Specimens from Ye				
17	0.465	0.246	0.219	0.535
32	0.688	0.416	0.271	0.312

Id.

Patent Owner notes that, as shown in Table B, Ye's specimen 17, which had a grain size of 2 µm, satisfies only one of the claimed texture coefficient ratios, but that, in contrast, specimen 32, which had a grain size of 1 µm, satisfies only two different claimed ratios. Prelim. Resp. 45.

Patent Owner contends that Petitioner assumes that modifying Ye with processing conditions and the fine crystal grain size disclosed in Otsuka would necessarily retain the claimed texture coefficient ratios. Prelim. Resp. 46. Patent Owner notes that Petitioner does not offer any evidence or rationale to establish why these references disclosing a myriad of different, significant process conditions would have directed a skilled artisan to a copper foil having the claimed texture coefficient ratios, weight deviation, and tensile strength with a reasonable expectation of success. *Id.*

4. <u>Analysis</u>

We conclude that Petitioner fails to meet its burden of showing, with a reasonable likelihood of success at trial, that a person of ordinary skill in the art would have found it obvious to combine the teachings of Ye, Hara, and Otsuka with a reasonable expectation of success in combining the references to arrive at the claimed invention. *See KSR*, 550 U.S. at 418 (holding that obviousness requires "a reason that would have prompted a person of ordinary skill in the relevant field to combine the elements in the way the claimed new invention does").

As an initial matter, we note that, of the 44 specimens tested by Ye, as revealed in Ye's Table II, only a single specimen, specimen 15, meets the required TC ratios recited in challenged claim 1 of the '541 patent. Furthermore, none of the references cited by Petitioner teach, or even remotely suggest, the four requisite TC ratios recited by challenged claim 1. We find Petitioner's argument that a person of ordinary skill in the art would have been motivated to exclusively select Ye's sample 15, out of the remaining 43, to which to apply the teachings of Hara and Otsuka concerning the requisite tensile strength and weight deviation ranges in the hope of arriving at the claimed invention, is implausible. Indeed, only the '541 patent, among all of the evidence of record, that actually mentions the required texture coefficient ratios recited in challenged claim 1. Petitioner provides no convincing argument as to why a skilled artisan would have selected sample 15 for combination with Hara and Otsuka. Rather, Petitioner's argument appears to be based upon impermissible hindsight reconstruction.

However:

> Any judgment on obviousness is in a sense necessarily a reconstruction based upon hindsight reasoning, but so long as it takes into account only knowledge which was within the level of ordinary skill at the time the claimed invention was made and

> does not include knowledge gleaned only from applicant's disclosure, such a reconstruction is proper.

In re McLaughlin, 443 F.2d 1392, 1395 (C.C.P.A. 1971). Accordingly, Petitioner's failure to suggest a reason as to why a person of ordinary skill in the art would have been motivated to select that single specimen, without knowledge of the specific TC ratios disclosed by the '541 patent argues against Petitioner's contention that the claims are obvious.

Furthermore, we are not persuaded that Petitioner sufficiently shows that a person of ordinary skill in the art would have had a reasonable expectation of success in combining the references to arrive at the claimed invention. We agree with Patent Owner's argument that:

> Petitioner does not offer any evidence or rationale to establish why these references [i.e., Ye, Hara, and Otsuka] disclosing a myriad of different, significant process conditions would have directed a skilled artisan to a copper foil having the claimed texture coefficient ratios, weight deviation, and tensile strength with a reasonable expectation of success.

See Prelim. Resp. 46.

Petitioner relies upon the testimony of Dr. Josefowicz that:

> [T]he optimization of weight deviation, elongation, and tensile strength values in copper foil 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 and other plating parameters such as solution agitation and temperature.

See Ex. 1003 ¶ 63. However, and as we explained in Section III.C.7 above, we find this testimony to be conclusory in nature and largely unsupported by evidence that a person of ordinary skill in the art would have been motivated to combine the specific film and methods of Ye with the methods and electrodeposited foils of Hara and Otsuka to achieve all of properties of the invention recited in challenged claim 1 with a reasonable expectation of success.

Petitioner's arguments with respect to claims 2–4 are largely repetitive of those advanced with respect to those claims in Ground 1. They fare no better here, for the reasons we explained in Section III.C.7 above. We consequently deny institution of *inter partes* review on Petitioner's Ground 2.

E. Ground 3: Alleged Obviousness of Claims 1–4 over Hirose, Hara, and Otsuka or Matsuda

1. Overview of Hirose (Ex. 1007)

Hirose is U.S. Patent Appl. Ser. No. US 2009/0061326 A1, published March 5, 2009. Ex. 1007, codes (10), (43). Hirose is directed to copper foils for use as the current collector of the anode of a battery. *Id.* at code (54). Specifically, Hirose teaches

> [A] current collector containing copper. In the current collector, ratio 1(200)/I (111) between intensity I (200) of a peak originated in (200) crystal plane of copper obtained by X-ray diffraction and intensity I (111) of a peak originated in (111) crystal plane thereof is in the range from 0.5 to 1.5.
>
> . . .
>
> Thus, the contact characteristics between the current collector and the active material layer are improved.

Id. ¶¶ 12, 15.

Hirose teaches that:

> In the case that the anode active material layer 2 is expanded or shrunk when an electrochemical device is operated, the extension (flexibility) of the anode current collector 1 is extremely important.… In the case that the extension coefficient is larger than 10%, a wrinkle may be generated in the anode current

> collector when the anode active material layer 2 is expanded and shrunk.

Ex. 1007 ¶ 49.

Hirose teaches that its anodal current collector comprises:

> [A] metal foil (so-called original foil) 1A and a plurality of fine particles 1B formed on the surface (for example, the both faces) thereof. In this case, the plurality of fine particles 1B may be fixed to the original foil 1A by being covered with a plated film 1C. Thereby, a plurality of projections are provided for every position of the fine particle 1B on the surface of the anode current collector 1. The plated film 1 C is formed by, for example, covering plating or burn plating.

Ex. 1007 ¶ 52. Hirose teaches, with respect to the anode active material:

> The anode active material layer 2 contains a plurality of anode active material particles containing silicon as an anode active material capable of inserting and extracting an electrode reactant. Silicon has the high ability to insert and extract the electrode reactant, and thereby provides a high energy density. The anode active material particle may be the simple substance, an alloy, or a compound of silicon; or a material having one or more phases thereof at least in part.

Id. ¶ 54.

2. Overview of Matsuda (Ex. 1012)

Matsuda is U.S. Patent Application Ser. No. US 2010/0038115 A1, published February 18, 2010. Ex. 1012, codes (10), (43). Matsuda is directed to:

> [A]n electrodeposited copper foil which has a lower profile and a higher gloss than low-profile electrodeposited copper foil conventionally supplied in markets. For achieving this object, the present invention employs an electrodeposited copper foil which has a super low profile, the surface roughness (R_{zjis}) of the deposit side of lower than 1.0-micron meter, and the gloss [Gs(60-deg.)] thereof of not lower than 400 irrespective to its thickness.

Ex. 1012, Abstr. Matsuda is further directed to "an electrodeposited copper foil obtained by electrodeposition using a sulfuric acid base copper electrolytic solution obtained by adding 3-mercapto-1-propane sulfonic acid and/or bis(3-sulfopropyl)disulfide, a quaternary ammonium salt polymer having a cyclic structure, and chlorine." *Id.*

Matsuda teaches that the "mechanical properties of copper foil as current collecting material, for bearing the repeated expansion/contraction behavior, are required to have a favorable balance between the tensile strength and elongation." Ex. 1012 ¶ 12.

Matsuda additionally teaches that:

> [I]n the electrodeposited copper foil according to the present invention, the shiny side preferably has a surface roughness (R_{zjis}) of lower than 2.0-micron meter, and gloss [Gs(60-deg.)] of not lower than 70.
>
> From the viewpoint of mechanical properties of the electrodeposited copper foil according to the present invention, the electrodeposited copper foil exhibits the mechanical properties of a tensile strength of not less than 33 kgf/mm^2 and an elongation of not less than 5% for as received.
>
> The electrodeposited copper foil according to the present invention exhibits the mechanical properties of a tensile strength after heating (180° C.x60 min, in the air) of not less than 30 kgf/mm^2 and an elongation after heating (180° C.x60 min, in the air) of not less than 8%.

Ex. 1012 ¶¶ 18–20.

3. <u>Petitioner's arguments</u>

Petitioner argues that Hirose teaches electrolytic copper foil surface having: (1) TC ratios; (2) R_z values; and (3) thickness values that fall within the claimed ranges of the '541 patent. Petitioner acknowledges that, although Hirose does not disclose the claimed: (1) weight deviation values;

(2) tensile strength values, and (3) elongation values, Hara provides teachings of weight deviation values and elongation values, and either Otsuka or Matsuda provides teachings of tensile strength values, which fall within the claimed ranges of the ’541 patent. Pet. 52–53. As such, argues Petitioner, the combination of Hirose, Hara, and Otsuka or Matsuda discussed with respect to claims 1–4 should not be taken to indicate any substantive difference between Hirose’s copper foil and that recited in the ’541 patent. *Id.* at 53. Rather, Petitioner asserts, the combination accounts for claim 1’s recitation of specific material properties that do not appear to have been measured (or simply not mentioned) together in any single identified reference. *Id.* (citing Ex. 1003 ¶ 169).

Petitioner argues that it would have been obvious to those of ordinary skill in the art to combine the references because: (1) all four references focus on enhancing battery durability and performance by mitigating mechanical stresses and improving adhesion properties of the electrode of a secondary lithium-ion battery; and (2) a skilled artisan, seeking to utilize or optimize Hirose’s electrolytic copper foil for use in secondary batteries, would have looked at other references, including Hara and Otsuka (or Matsuda), and would have recognized that factors such as weight deviation, elongation, and tensile strength are important for further optimizing Hirose’s electrolytic copper foil for use toward current collectors of secondary batteries. Pet. 53–54 (citing Ex. 1009, Abstr., ¶¶ 11, 12; Ex. 1010 ¶¶ 2, 3, 11–18; Ex. 1007 ¶¶ 116, 153–155; Ex. 1012 ¶ 12; Ex. 1003 ¶¶ 171–172).

Petitioner also argues that a skilled artisan would have had a reasonable expectation of success in combining the references because: (1) all of the cited references focus on providing electrolytic copper foil for use in lithium-ion secondary batteries, and those of ordinary skill would have expected success in applying the teachings of weight deviation, elongation, and tensile strength values of Hara and Otsuka (or Matsuda); (2) electrolytic copper foils with weight deviation were commercially available, and a skilled artisan would have recognized the ease of applying such teachings or otherwise would have been familiar with the recipes or methods to produce copper foils with the desired weight deviation characteristics; and (3) as Petitioner argued in Section III.C.5.e above, the optimization of weight deviation, elongation, tensile strength, and R_z values in copper foil would have involved a mere routine optimization of electrodeposition conditions. Pet. 55–57 (citing Ex. 1009 ¶ 27; Ex. 1003 ¶¶ 178–180).

4. Patent Owner's Preliminary Response

Patent Owner argues that Petitioner selectively picks foil properties from the four different references in the same manner as it did for Grounds 1 and 2. Prelim. Resp. 35. According to Patent Owner, Petitioner relies on Hirose as disclosing texture coefficient ratios that fall within the claimed ranges. *Id.* (citing Pet. 58–61; Ex. 1003 ¶¶ 183–190). Petitioner recognizes that Hirose does not disclose: (1) the claimed weight deviation range; or (2) the claimed range of tensile strengths recited in challenged claim 1, and relies on Hara and Otsuka/Matsuda, respectively, as teaching these limitations. *Id.* (citing Pet. 61–63; Ex. 1003 ¶¶ 191–197).

Patent Owner asserts that for Ground 3, as in Grounds 1 and 2, Petitioner's arguments assume that the different foil properties selected from each reference are all interchangeable. Prelim. Resp. 35. However, Patent Owner argues, Petitioner does not substantiate a reasonable expectation that the foil properties selectively chosen from at least three different references could be predictably combined to arrive at Patent Owner's claimed invention. *Id.* at 35–36. Rather, Patent Owner argues, Petitioner only asserts that there would have been a reasonable expectation of success because each reference discloses similar process parameters for making an electrolytic copper foil. *Id.* at 36 (citing, e.g., Pet., 15–16).

With respect to Hara in particular, Patent Owner argues, Petitioner also surmises that a person of ordinary skill in the art "would have known that electrolytic copper foils with weight deviation in the claimed range were commercially available and therefore would have recognized the ease of applying such teachings." Prelim. Resp. 36 (citing Pet. 15). Patent Owner contends that, in essence, Petitioner argues that because each reference discloses electroplated copper foils, there would have been a reasonable expectation of success in combining them. *Id.*

Patent Owner alleges that Petitioner makes no comparison between the processing conditions and parameters from the different references, and Petitioner does not explain why the foil properties from one reference would be compatible with the properties from another reference. Prelim. Resp. 37. By way of example, Patent Owner points to Petitioner's statement that "it was conventional to vary the electrolyte concentration, electrolysis plating parameters, temperature, and the use of organic and inorganic additives, in order to obtain a copper foil with tensile strength," as recited in challenged claim 1. *Id.* (quoting Pet. 16). However, argues Patent Owner, the fact that that there allegedly may be some overlap in process conditions alone does not support that properties of foils from three different references could be predictably combined with a reasonable expectation of success. *Id.*

Patent Owner particularly contends, with respect to the tensile strength, Table 2 from Exhibit 1025, cited on page 16 of the Petition, contradicts Petitioner's argument. Table 2, with Patent Owner's annotation, is again reproduced below:

Table 2. PROPERTIES OF COPPER ELECTRODEPOSITS USEFUL FOR DIVERSE APPLICATIONS

Outstanding Characteristic	Tensile Strength, kg/mm^2	Elongation, % (5cm)	Internal Stress,[c] kg/mm^2	Hardness (VHN_{200}), kg/mm^2	Electrical Resistivity, michrohm-cm
High strength	45–63.5	4–18	−4.2 or 3.6 to 5.5	131–159	1.75–2.02
Hardness	3.5–55.5	0–10	−4.2 or 3.0	193–350	1.96–4.60
Low electrical resistivity	18.5–27	15–41	−0.5 to −1.6	48–64	1.70–1.73
Near zero stress	14–16	8–24	−0.08–0.06	56–57	1.71–1.72
Good leveling	36–36.5	14–19	2.0	128–137	1.82
Thermal stability[b]	22.5–30	26–39	0.5–2.9	55–106	1.73–1.76

[a]Negative values indicate a compressive stress.
[b]Deposits that changed less than 0.02% in length after heating to 400°C.

Patent Owner argues that the table shows that varying process conditions and parameters can result in tensile strengths ranging from of 45 to 63.5 kg/mm^2; at least 12.5% greater than the upper end of the claimed range of 40 kg/mm^2. Prelim. Resp. 38.

Moreover, argues Patent Owner, with respect to weight deviation, Petitioner states that "it would have been obvious to a POSITA to use an electrolytic copper foil with minimal weight variance across the foil, but that such recognition likely was not expressly stated due to the overwhelming obviousness of the fact." Prelim. Resp. 38 (quoting Pet. 15) (emphasis omitted). Patent Owner notes that Petitioner does not explain why the process conditions that achieve the crystal structure ratios and tensile strength in other cited references would have reasonably been expected to achieve a weight deviation of 3% or less as claimed. *Id.* Patent Owner points to Hara (the only reference relied on by Petitioner as disclosing weight deviation), which, Patent Owner contends, does not support Petitioner's argument because Hara is silent with respect to electrolytic process conditions for making a copper foil. *Id.* Patent Owner contends that the fact that the references disclose electroplated copper foils does not establish that there would have been a reasonable expectation of success in combining foil properties from three different references to arrive at the invention claimed by the '541 patent. *Id.* at 39.

Additionally, Patent Owner repeats its arguments presented above with respect to Ground 1. Prelim. Resp. 39–41, 46–48 (*see* Section III.C.6, *supra*).

5. Analysis

Although we conclude that the Petitioner again fails, for the same reasons we have explained above, to meet its burden of demonstrating a reasonable likelihood of success in demonstrating at trial that the challenged claims are obvious, this Ground provides us with a somewhat closer call, if only because all of the references are drawn to copper foils for use as anodal current collectors. Nevertheless, the fundamental flaw of Petitioner's argument persists in that Petitioner fails to articulate a reason why a person of ordinary skill in the art would have had a reasonable expectation of success in combining the references to arrive at the claimed invention.

At the heart of this flaw is Petitioner's argument, and Dr. Josefowicz's opinion, that it would have been conventional in the art at the time of filing to vary the electrolyte concentration, electrolysis plating parameters, temperature, and the use of organic and inorganic additives, in order to obtain a copper foil with tensile strength and elongation values falling within the claimed ranges as these ranges were well known, at least since 1974. Ex. 1003 ¶ 63. This statement is largely unsupported by evidence of record, with the sole exception of Table 2 of Lowenheim[15], which, as Patent Owner points out, provides tensile strengths well outside the claimed range. Petitioner provides insufficient guidance as to how a person of ordinary skill in the art would have known which parameters to vary, or how to vary them, to provide the foil of Hirose with a tensile strength or weight deviation within the claimed range. Dr. Josefowicz's statement that this would result from routine optimization, and was "conventional" may or may not be true, but it is insufficiently supported by evidence of record to be persuasive.

In short, Petitioner is plucking various properties of copper foils from various references, each of which employs significantly different starting materials and methodologies, and, without sufficient persuasive evidence of record, asserting that a person of ordinary skill in the art would know how to vary a number of different interacting operational variables (e.g., electrolyte concentration, electrolysis plating parameters (including voltage, current, duration, and temperature), and the use of organic and inorganic additives) to result in a foil having all of the combined properties recited in challenged claim 1. This applies equally, if not more so, to the additional qualities recited in dependent claims 2–4.

For these reasons, and for the additional reasons we explained with respect to Grounds 1 and 2, we conclude that Petitioner fails to meet its burden of showing a reasonably likelihood of prevailing at trial in showing

[15] F.A. Lowenheim, MODERN ELECTROPLATING (Wiley 1974) Ex. 1025.

that challenged claims 1–4 of the ’541 patent would have been obvious over the combination of Hirose, Hara, and Otsuka or Matsuda.

F. Discretionary Denial of Institution under 35 U.S.C. §§ 314(a) and 325(d)

Because we deny institution of *inter partes* review on the merits, we do not reach the parties’ arguments in this respect.

IV. CONCLUSION

For the foregoing reasons, we conclude that Petitioner fails to establish a reasonable likelihood of prevailing at trial in showing that the cited prior art references render obvious challenged claims 1–4 of the ’541 patent, as set forth in the asserted Grounds 1–3. 35 U.S.C. § 314(a). We consequently decline to institute *inter partes* review of the challenged claims of the ’541 patent.

V. ORDER

In consideration of the foregoing, it is hereby:

ORDERED, pursuant to 35 U.S.C. § 324(a), that the Petition for *inter partes* review of the challenged claims of U.S. Patent 9,457,541 B2 is DENIED with respect to all grounds in the Petition; and

FURTHER ORDERED that *inter partes* review is not instituted.

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