

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Patent of: Kim et al.
U.S. Patent No.: 9,457,541 Attorney Docket No. 57533-0005IP1
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Title: COPPER FOIL FOR CURRENT COLLECTOR OF LITHIUM
SECONDARY BATTERY WITH IMPROVED WRINKLE
CHARACTERISTICS

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PETITION FOR *INTER PARTES* REVIEW OF
UNITED STATES PATENT NO. 9,457,541
PURSUANT TO 35 U.S.C. §§ 311–319, 37 C.F.R. § 42

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LIST OF EXHIBITS

SOLUS-1001	U.S. Patent No. 9,457,541 (“the ’541 Patent”)
SOLUS-1002	U.S. Patent No. 9,457,541 File History
SOLUS-1003	Declaration of Dr. Jack Josefowicz
SOLUS-1004	Barclay, William R. et al., <i>Electroplating</i> —A Treatise on the Electro-Deposition of Metals with a Chapter on Metal-Colouring and Bronzing, London-Edward-Arnold, 1912
SOLUS-1005	Swantson, Howard and Tatge, Eleanor, <i>Standard X-ray Diffraction Powder Patterns</i> , National Bureau of Standards, Circular 539, Vol. 1, June 15, 1953.
SOLUS-1006	Reserved
SOLUS-1007	U.S. Patent Application Publication No. 2009/0061326 (“Hirose”)
SOLUS-1008	Japanese Patent Application Publication No. JP 2003051340 (“Hara”)
SOLUS-1009	Translation of SOLUS-1008
SOLUS-1010	U.S. Patent Application Publication No. 2004/0029006 (“Otsuka”)
SOLUS-1011	U.S. Patent Application Publication No. 2010/0136434 (“Hanafusa”)
SOLUS-1012	U.S. Patent Application Publication No. 2010/0038115 (“Matsuda”) (now US Patent 8,722,199 from Japanese Patent Application Publications No. JP2006-009321 and JP2005-104540)

SOLUS-1013	Ye, Xingpu, et al. 1992 “Role of Overpotential on Texture, Morphology and Ductility of Electrodeposited Copper Foils for Printed Circuit board Applications”, <i>J. Electrochem. Soc.</i> , Vol. 139, No. 6, 1592 (June 1992) (“Ye”)
SOLUS-1014	Chiang, S.K. DiFranco, D.F. and Pucci, D.G. (1995), “High Strength, Low Profile Copper Foil for High Performance PCBs,” <i>Circuit World</i> Vol. 21 No. 3, pp. 56-59. (“Chiang”)
SOLUS-1015	Reserved
SOLUS-1016	Chinese Patent Publication CN1710737A (“Zhang”), published December 21, 2005
SOLUS-1017	Translation of SOLUS-1016
SOLUS-1018	Kim, Jongsoo and Kim, Heesan, <i>Corrosion Science and Technology</i> , Vol. 6, No. 4, pp. 154-158 (2007). (“Kim”)
SOLUS-1019	U.S. Patent No. 4,695,348 (“Battey”)
SOLUS-1020	U.S. Patent No. 6,451,441 (“Nishimoto”)
SOLUS-1021	U.S. Patent Application Publication No. 2004/0149583 (“Kumagai”)
SOLUS-1022	U.S. Patent Application Publication No. 2009/0047539 (“Dobashi”)
SOLUS-1023	U.S. Patent Application Publication No. 2006/0191798 (“Sano”)
SOLUS-1024	Reserved
SOLUS-1025	Frederick A. Lowenheim, <i>Modern Electroplating</i> , John Wiley & Sons, 1974 (“Lowenheim”)

SOLUS-1026	Reserved
SOLUS-1027	Japanese Patent Pub. No. JP 2007/217787 (“Matsuda-787”)
SOLUS-1028	Translation of SOLUS-1027
SOLUS-1029	<i>Surface roughness – Definitions and designation</i> , Japanese Industrial Standard (JIS) B 0601-1994 (“JIS Standard 1994”)
SOLUS-1030	<i>Geometrical Product Specifications (GPS) – Surface texture: Profile method – Terms, definitions and surface texture parameters</i> (“JIS Standard 2001”)
SOLUS-1031	<i>Operating Instructions MarSurf M 300 + RD 18</i> , Mahr GmbH, 2008 (“MarSurf M300 instruction manual”)
SOLUS-1032	<i>Surface Roughness Measurement-Parameters</i> , Olympus, https://www.olympus-ims.com/en/metrology/surface-roughness-measurement-portal/parameters/ (“Olympus”)
SOLUS-1033-1035	Reserved
SOLUS-1036	Declaration of June Ann Munford
SOLUS-1037	<i>SK nexilis Co., Ltd. v. Solus Advanced Materials Co., Ltd. et al.</i> , Case 2-23-cv-00539 (EDTX), First Amended Complaint
SOLUS-1038	<i>SK nexilis Co., Ltd. v. Solus Advanced Materials Co., Ltd. et al.</i> , Case 2-23-cv-00539 (EDTX), Proposed Docket Control Order
SOLUS-1039	<i>SK nexilis Co., Ltd. v. Solus Advanced Materials Co., Ltd. et al.</i> , Case 2-23-cv-00539 (EDTX), Opposed Motion of Defendant to Transfer Venue

LISTING OF CLAIMS

Claim 1	
[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: $TC(hkl) \geq \frac{\frac{I(hkl)}{I_0(hkl)}}{\frac{1}{n} \sum \frac{I(hkl)}{I_0(hkl)}}$ wherein I(hkl) represents a measured diffraction intensity with respect to a (hkl) surface, and I₀(hkl) represents a standard diffraction intensity of ASTM (American Society of Testing Materials) standard powder-shaped diffraction data,
[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.
Claim 2	
[2]	The copper foil for a current collector of a lithium secondary battery according to claim 1, wherein the copper foil has a surface roughness (R _z - JIS) of 2 μm or less.

Claim 3	
[3]	The copper foil for a current collector of a lithium secondary battery according to claim 1, wherein the copper foil has an elongation of 3 to 20%.
Claim 4	
[4]	The copper foil for a current collector of a lithium secondary battery according to claim 1, wherein the copper foil has a thickness of 1 to 35 μm .

I. INTRODUCTION

Solus Advanced Materials Co., Ltd. (“Solus” or “Petitioner”) petitions for IPR of claims 1-4 (“Challenged Claims”) of U.S. Patent No. 9,457,541 (“the ’541 Patent”). As explained in this petition, there exists a reasonable likelihood that Petitioner will prevail with respect to at least one of the Challenged Claims.

II. REQUIREMENTS FOR IPR UNDER 37 C.F.R. § 42.104

A. Grounds for Standing Under 37 C.F.R. § 42.104(a)

Solus certifies that the ’541 Patent is available for IPR. The present petition is being filed within one year of service of a complaint in *SK nexilis Co., Ltd. v. Solus Advanced Materials Co., Ltd. et al.*, Case 2-23-cv-00539 (EDTX), filed November 21, 2023, and amended on May 15, 2024 to add the ’541 Patent. SOLUS-1037. Petitioner is not barred or estopped from requesting this review of the Challenged Claims on the below-identified grounds.

B. Challenge Under 37 C.F.R. § 42.104(b) and Relief Requested

Petitioner requests an IPR of the Challenged Claims on the grounds set forth in the table shown below. Additional explanation and support for each ground is set forth in SOLUS-1003, the Declaration of Dr. Jack Josefowicz (“Expert Declaration”), referenced throughout this Petition. SOLUS-1003, ¶¶1-217.

Ground	'541 Patent Claims	Basis for Rejection
1	1-4	§103: Kim + Hara + Otsuka
2	1-4	§103: Ye + Hara + Otsuka
3	1-4	§103: Hirose + Hara + Otsuka or Matsuda

The '541 Patent issued from U.S. Application No. 13/722,585 and claims priority to Japanese Application No. 2010-161088, filed July 15, 2010. Although priority entitlement is not conceded, the earliest claimed priority date of the '541 Patent is July 15, 2010. Each reference qualifies as prior art, as shown below.

SOLUS-1036.

Reference	Filed	Published	Pre-AIA Prior Art Qualification
Hirose	2008-05-20	2009-03-05	§ 102(b)
Hara	2001-08-07	2003-02-21	§ 102(b)
Otsuka	2003-07-29	2004-02-12	§ 102(b)
Ye		1990-10-19	§ 102(b)
Matsuda	2007-09-28	2010-02-18	§§ 102(a), 102(e)
Kim		2007-08-31	§ 102(b)

III. SUMMARY OF THE '541 PATENT

A. Brief Description

The '541 Patent purports to describe a “copper foil for a current collector of a lithium secondary battery.” SOLUS-1001, Abstract. As discussed in the '541

Patent's Background, copper foils are commonly used as the anode current collector in lithium secondary batteries. *Id.*, 1:38-40. However, according to the '541 Patent, "[i]n case a wrinkle exists on a surface of a copper foil ... active material is not uniformly coated due to the irregularity of the surface shape, which ***may cause a short-circuit or separate the active material from the copper foil during a charging or discharging process.***" *Id.*, 1:58-62.¹

"Battery characteristics of a lithium secondary battery are greatly changed in accordance with ***a surface state of a copper foil*** used as a current collector, so ***it is very important to improve surface characteristics*** such as wrinkle characteristics ***in order to improve a yield.***" *Id.*, 1: 53-57.

Thus, the '541 Patent's alleged goals are to [1] improve yield, [2] prevent a short circuit, and [3] keep active material on the copper foil during battery operation. The supposed means to achieving these goals are to produce copper foil with certain material characteristics that purportedly prevent wrinkles on a surface of the copper foil.

The '541 Patent purports to provide copper foils "with a crystalline structure capable of decreasing the generation of wrinkles at a surface of the copper foil." *Id.*, 2:2-4. In this regard, the '541 Patent highlights several features of the copper

¹ Emphasis added throughout unless otherwise noted.

foils that allegedly provide a decrease in the generation of wrinkles.

First, the '541 Patent outlines four specific ratios of texture coefficients, derived from X-ray diffraction measurements, that must fall within defined ranges to ensure proper adhesion of the active material to the copper foil surface. *Id.*, 3:52-4:3.

Second, the '541 Patent states that the copper foil must have several physical parameters (weight deviation and tensile strength for the independent claims and surface roughness, elongation, and foil thickness for the dependent claims) within certain ranges. *Id.* 4:20-30, 40-45.

The '541 Patent states “the copper foil should satisfy the following conditions: a tensile strength of 30 to 40 kgf/mm², an elongation of 3 to 20%, and a thickness of 1 to 35 μ m. Out of the above ranges, the properties of the copper foil are deviated to increase the number of wrinkles, and the properties of the current collector become irregular.” *Id.*, 4:40-45.

In addition, the '541 Patent describes “Surface roughness (R_z) of the copper foil should be 2 μ m or less, based on JIS (Japanese Industrial Standards). In case the surface roughness (R_z) exceeds 2 μ m, the surface is irregular, so a short circuit may occur during a charging or discharging process. In addition, the coating state of the anode active material becomes irregular.” *Id.*, 4:20-25.

B. Prosecution History of the '541 Patent

U.S. 9,457,541 issued from U.S. Patent Application No. 13/722,585, which was filed on December 20, 2012 and claims benefit of a parent application 13/029,656 filed on February 17, 2011, which claims benefit of a patent application filed in Japan (2010-161088) with a priority date of July 15, 2010.

Prosecution of the '541 patent, across several Office Actions, cited the following references: US 2004/0149583 (SOLUS-1021), US 2009/0061326 (SOLUS-1007), US 6,451,441 (SOLUS-1020), US 4,695,348 (SOLUS-1019), US 2010/0038115 (SOLUS-1012).

The Office allowed the application after several rounds of amendments, ultimately granting allowance after the Patentee added “so as to prevent the generation of wrinkles at a surface of the copper foil.”² As to the reason for allowance, the Notice of Allowance stated that “[t]he prior art of record does not teach or suggest a copper foil having the claimed texture coefficients so as to prevent wrinkle generation.” SOLUS-1002, 21.

The reasons for allowance suggest that the Examiner’s consideration of the prior art was incomplete, however. For example, the file history contains no indication that the Examiner had been presented with or considered Kim (SOLUS-

² As further explained *infra*, this limitation should not be given patentable weight.

1018), Hara (SOLUS-1008), Otsuka (SOLUS-1010), or Ye (SOLUS-1013)—i.e., the references presented in Grounds 1-3 of this Petition—during original examination of the '541 Patent. If these references had been fully considered, the Challenged Claims should not have been allowed and the '541 Patent should not have issued.

C. Level of Ordinary Skill

A person of ordinary skill in the art (“POSITA”) 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. Additional education, such as a graduate degree, could compensate for less work experience, and additional work experience could compensate for less formal education. SOLUS-1003, ¶¶16.

D. Claim Construction

Petitioner submits that all claim terms should be construed according to the *Phillips* standard. *Phillips v. AWH Corp.*, 415 F.3d 1303 (Fed. Cir. 2005); 37 C.F.R. § 42.100. Here, based on the evidence below and the prior art’s description of the claimed elements being similar to that of the '541 Patent’s specification, and because the Challenged Claims are obvious under any reasonable interpretation, no

formal claim constructions are necessary in this proceeding because “claim terms need only be construed to the extent necessary to resolve the controversy.”

Wellman, Inc. v. Eastman Chem. Co., 642 F.3d 1355, 1361 (Fed. Cir. 2011).³

IV. GROUND 1: Claims 1-4 are obvious over Kim in view of Hara and Otsuka

A. Overview of Kim

Kim analyzes the effects of organic additives (e.g., inhibitors, levelers, and accelerators) on the surface smoothness and internal stress of electroplated copper foils used in flexible printed circuit board (PCB). SOLUS-1018, Abstract; SOLUS-1003, ¶42.

As an initial matter, Kim explains that among such organic additives, *inhibitors* and *levelers* slow down the overall copper deposition, and lead to a copper foil having a *smoother surface but an increased internal stress* of the copper layer. SOLUS-1018, 1⁴, Abstract; SOLUS-1003, ¶43.

Further, Kim explains that among such organic additives, *accelerators*, when used in controlled amounts, enhance copper deposition in the lower areas or

³ Petitioner is not conceding that each claim satisfies all statutory requirements, such as §§ 101 and 112, nor is Petitioner waiving any arguments concerning claim scope or grounds that can only be raised in district court.

⁴ Referring to the page number of the PDF document.

valleys, and lead to a copper foil having a *smoother surface and reduced internal stress reduced internal stress*. SOLUS-1018, 1, Abstract; SOLUS-1003, ¶44.

Kim also discloses the *texture coefficient (TC)*, which provides insight into the dominant crystal planes within the electroplated copper. *Id.*, 2, Equation 3 (reproduced below, annotated). Kim found that the *accelerator shifts the preferred crystal orientation from the (220) plane to the (200) plane*, which is *associated with lower internal stress*. *Id.*, 4; SOLUS-1003, ¶45.

Kim's findings highlight the *accelerator's* beneficial effect in *reducing internal stress* while *improving surface properties*. These are reflected in below Table 1 (annotated) and Figure 4 (annotated), which illustrate how the use of the accelerator produces a crystal orientation with [1] reduced internal stress and [2] a smoothened surface, exhibiting corresponding TC ratios and Rz values that fall within the claimed ranges of the '541 patent, as will be further described below. *Id.*, Table 1 and FIG. 4 (reproduced below, annotated); SOLUS-1003, ¶46.

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)

SOLUS-1018, Table 1 (annotated)

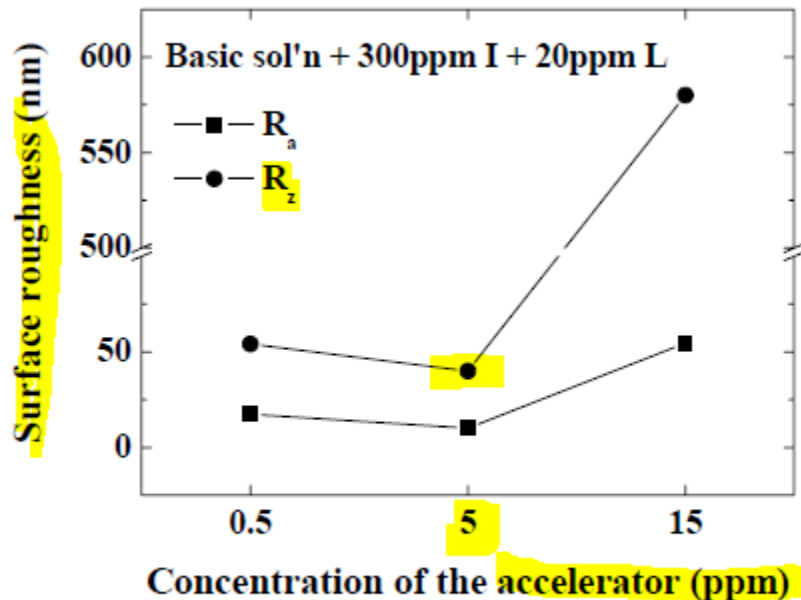


Fig. 4. Surface roughness with the concentration of the accelerator (I: inhibitor, L: leveler, A: accelerator).

SOLUS-1018, FIG. 4 (annotated)

B. Overview of Hara

Hara describes copper foils used as negative electrodes for lithium secondary batteries. More specifically, Hara seeks to provide “lithium secondary batteries with *small variations in battery capacity* and *long life*.” SOLUS-1009,⁵ Abstract; SOLUS-1003, ¶48.

In this regard, Hara discloses an electrolytic copper foil that is “used for the negative electrode current collector with *a variation in weight per unit area of 2%*”

⁵ JP 2003/051340A to Hara (SOLUS-1008) was published in Japanese. Thus, all citations to Hara are to its English translation (SOLUS-1009).

or less and an elongation rate of 5% or less.” SOLUS-1009, Abstract, [0012].

According to Hara, “since an electrolytic copper foil with a weight variation per unit area of 2% or less is used for the negative electrode current collector, *the variation in thickness of the negative electrode current collector can be suppressed and the electrode reaction can be made uniform*” and “since an electrolytic copper foil with an elongation of 5% or less . . . the distortion when pressed to a predetermined bulk density is small, *preventing the occurrence of spontaneous short circuits, and a battery with small variation in battery capacity and long life can be obtained.*” SOLUS-1009, [0012], [0063]. Further, in such cases, Hara describes 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.*” SOLUS-1009, [0013]; SOLUS-1003, ¶49.

Hara also recognizes that “[i]f the negative electrode stretches too much, it will undulate in the width direction, causing problems such as *wrinkles during the winding process* and misalignment of the opposing positive and negative electrodes.” SOLUS-1009, [0008]; SOLUS-1003, ¶50.

C. Overview of Otsuka

Otsuka describes “*An 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, and having a *high elongation rate* even in a high temperature atmosphere. The electrodeposited copper foil has a *surface roughness Rz* at a deposition surface at ordinary temperature smaller than 2.5 μm in terms of *10-point average roughness Rz*, has a minimum distance between peaks of a base foil peak of at least 5 μm , has an ordinary temperature *tensile strength of not more than 40 kg[f]/mm²*,⁶ and has a drop in ordinary temperature tensile strength after heat treatment at 130 °C for 15 hours of less than 15%. *Also, copper foil for a secondary battery collector using that foil.*” SOLUS-1010, Abstract; SOLUS-1003, ¶51.

D. Combination of Kim, Hara, and Otsuka

It would have been obvious to a POSITA to combine the teachings of Kim, Hara, and Otsuka, the combination of which would render obvious the claimed copper foil of the '541 patent. SOLUS-1003, ¶52.

As an initial matter, it is not conceded that any modifications to Kim would

⁶ Otsuka used ‘kg/mm²’ when ‘kgf/mm²’ was intended. As explained by Dr. Josefowicz, a POSITA would have understood that the actual measure of tensile strength is in kgf/mm² (kilogram-force per square millimeter), not kg/mm² (kilogram per square millimeter). SOLUS-1003, ¶51.

actually be necessary in order to obtain the copper foils recited in claims 1-4. Kim discloses electrolytic copper films having [1] TC ratios, [2] thickness values, and [3] Rz values that fall within the claimed ranges of the '541 Patent. While Kim does not mention specific [1] weight deviation, [2] tensile strength values, and [3] elongation values, Hara provides explicit measurements of such weight deviation values and elongation values, and Otsuka provides explicit measurements of tensile strength values and elongation values, which fall within the claimed range of the '541 Patent. As such, the combination of Kim with Hara and Otsuka discussed with respect to claims 1-4 should not be taken to indicate any substantive difference between Kim's copper foil and that recited in the '541 Patent. Rather, 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. Indeed, there is "need for caution in granting a patent based on the combination of elements found in the prior art." *KSR International Co. v. Teleflex Inc.*, 550 U.S. 398, 401 (2007). For the present case, in which many of the claims rely on the relative obscurity of their measurements rather than on novel structures or methods, the need for caution is heightened even further. SOLUS-1003, ¶53.

At least for the following reasons, it would have been obvious to a POSITA to have combined Kim with Hara and with Otsuka, especially as the prior art

provides sufficient motivation and guidance for modifying Kim's copper foil to obtain the desired ratios of the texture coefficients while taking advantage of Hara's disclosed weight deviation of $\leq 2\%$ and elongation $\leq 5\%$ and Otsuka's disclosed tensile strength $\leq 40 \text{ kgf/mm}^2$. SOLUS-1003, ¶54.

First, Kim discloses copper foil for use in PCB, which a POSITA would have recognized as being compatible for use in secondary battery applications. Indeed, such use compatibility of electrolytic copper foil between the PCB and the secondary batteries was well-known. SOLUS-1022, [0107]; SOLUS-1023, [0001], [0005], [0012], [0066]; SOLUS-1012, [0010], [0012], [0052]. SOLUS-1003, ¶55.

Second, a POSITA seeking to utilize or optimize Kim's electroplated copper foil (e.g., 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, and tensile strength are important for further optimizing Kim's copper foil for use in secondary batteries. SOLUS-1003, ¶56.

For example, Hara describes that an electrolytic copper foil having “*weight variation per unit area of 2% or less*” and “*elongation of 5% or less*” prevent “the occurrence of spontaneous short circuits” and helps obtaining “a battery with small variation in battery capacity.” SOLUS-1009, [0012], [0063]. Further, for example,

Hara describes that “by using electrolytic copper foil with a *weight variation of 2% or less*, a thickness of 10 μm , and a surface roughness of Rz of 2.0 μm or less in the negative electrode current collector, a battery with *excellent cycle life characteristics can be realized*.” *Id.*, [0013], [0051]; SOLUS-1003, ¶57.

Moreover, Otsuka describes that an electrolytic copper foil with a tensile strength of “not more than 40 kg[f]/mm²” maintains or enhances adhesion between a current collector and an active material of the battery, which results in superior “charge/discharge cycle life and productivity” of secondary batteries. SOLUS-1010, Abstract, [0020], [0029], [0030], [0031], [0033]; SOLUS-1003, ¶58.

Therefore, at least for the reasons set forth above, a POSITA would have been motivated to optimize Kim’s electrolytic copper foil for use in secondary batteries by applying the exemplary teachings of Hara and Otsuka to optimize weight deviation, elongation, and tensile strength values. SOLUS-1003, ¶59.

Further, a POSITA would have expected success at least for the following reasons. SOLUS-1003, ¶60.

First, as described above, since both Hara and Otsuka focus on providing electrolytic copper foils for use in lithium-ion secondary batteries and the use compatibility of electrolytic copper foils between the PCB and secondary batteries was well known, a POSITA would have expected success in applying the teachings of weight deviation, elongation, and tensile strength values of Hara and Otsuka.

SOLUS-1003, ¶61.

Second, a POSITA 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 and that copper foils were being produced in the industry with the desired range of different weight deviation characteristics. For example, as described above, Hara describes in one example that an electrolytic copper foil with the desired weight deviation of 2% or less is obtained from commercially available suppliers such as “Furukawa Circuit Foil Co., Ltd.” SOLUS-1009, [0027]. Further, Dr. Josefowicz notes that, in regard to use of copper foil for a current collector of a negative electrode of secondary battery, 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. SOLUS-1003, ¶62.

Third, as explained by Dr. Josefowicz, the 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. For example, as explained by Dr. Josefowicz, 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 as these ranges were well known, at least since 1974, as illustrated below. SOLUS-1025, 18, Table 2 (reproduced below); SOLUS-1003, ¶63.

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, microhm-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

^aNegative values indicate a compressive stress.
^bDeposits that changed less than 0.02% in length after heating to 400°C.

SOLUS-1025, 18, Table 2

Therefore, a POSITA would have been motivated to apply or optimize weight variation, tensile strength, and elongation features on Kim’s electrolytic copper foil and expected success. *See In re Aller*, 220 F.2d 454, 456 (C.C.P.A. 1955) (“where the general conditions of a claim are disclosed in the prior art, it is not inventive to discover the optimum or workable ranges by routine experimentation”); *see also KSR*, 550 U.S. at 401 (holding that “obvious to try” is

a valid rationale for an obviousness finding); *see also Pfizer, Inc. v. Apotex, Inc.*, 480 F.3d 1348, 1364 (Fed. Cir. 2007) (emphasizing that “obviousness cannot be avoided simply by a showing of some degree of unpredictability in the art so long as there was a reasonable probability of success”); SOLUS-1003, ¶64.

E. Analysis of Claims

[1pre]:

To the extent the preamble is limiting, Kim-Hara-Otsuka renders obvious [1pre]. For example, 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. Such use compatibility of electrolytic copper foil between the PCB and the secondary batteries was well-known.

SOLUS-1022, [0107]; SOLUS-1023, [0001], [0005], [0012], [0066]; SOLUS-1012, [0010], [0012], [0052]. Therefore, in the combination, Kim discloses a copper foil for a current collector of a lithium-ion secondary battery. SOLUS-1003, ¶65.

[1a]-[1b]:

Kim-Hara-Otsuka’s disclosure of the foregoing values within the claimed range renders obvious [1a]-[1b]. “It is [] an elementary principle of patent law that when, as by a recitation of ranges or otherwise, a claim covers several compositions, the claim is ‘anticipated’ if one of them is in the prior art.” *Titanium*

Metals Corp. of America v. Banner, 778 F.2d 775, 782 (Fed. Cir. 1985), citing *In re Petering*, 301 F.2d 676, 682 (C.C.P.A 1962). Absent criticality (which has not been alleged or demonstrated here), “ranges which overlap or lie within ranges disclosed by the prior art” are obvious. *In re Wertheim*, 541 F.2d 257, 267 (C.C.P.A. 1976); SOLUS-1003, ¶66.

As an initial matter, Dr. Josefowicz explains that texture coefficient is a measure of the prominence of the x-ray diffraction (XRD) peak of a given plane, relative to other planes. SOLUS-1003, ¶67.

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)

SOLUS-1018, Table 1 (annotated)

Kim’s Table 1 shows texture coefficients for two of Kim’s copper foils. SOLUS-1018, Table 1 (annotated, reproduced above). As described in the “Overview of Kim” section, Kim describes how the use of accelerator 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. The copper foil data showing the TC ratios that fall within the claimed range is presented in the row labelled “300ppm I + 20ppm L + 5ppm A” in Table 1. SOLUS-1018, 5, Table 1. This copper foil data in Table 1 of Kim has been used

to calculate four TC ratios recited in [1a]-[1b], as outlined in Tables 2 and 3 below.

SOLUS-1003, ¶68.

Table 1 provides a simplified visualization of the data (second sample copper foil) labelled “300ppm I +20ppm L + 5ppm A” in Table 1 of Kim. Further, Table 2 presents the TC ratio calculations, which fall within the claimed ranges.

SOLUS-1003, ¶69.

Table 1. Kim texture coefficients

Peak	TC(hkl)
(111)	0.88
(200)	1.15
(220)	0.97

Table 2. Kim ratio check

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

As shown, the example of Kim shown in Table 2 falls within the ratio ranges for all four ratios. SOLUS-1003, ¶71.

Thus, in the combination, Kim discloses copper foils within the limits of the ratios of the texture coefficients as recited by the '541 patent, rendering obvious [1a]-[1b]. SOLUS-1003, ¶¶71-74.

[1c]:

The Kim-Hara-Otsuka combination renders obvious [1c]. SOLUS-1003, ¶75.

As an initial matter, weight variation in Hara corresponds to weight deviation in [1c]. For example, according to the '541 Patent, “the 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.*” SOLUS-1001, 4:30-39. As such, as explained by Dr. Josefowicz, the '541 Patent's determination of “weight deviation” first measures the weight of a standard area and “converting the weight into a weight of the copper foil per a unit area,” in which the “weight deviation” is the equivalent of Hara's “weight variation per unit area.” SOLUS-1003, ¶76.

In line with this, Hara 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 Examples 1 and 2. SOLUS-1009, Abstract, [0011], [0012], [0015], [0027], [0029], [0048]; SOLUS-1003, ¶77.

Further, Hara 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. *Id.*, [0012], [0048], [0050], [0051]; SOLUS-1003, ¶78.

Additionally, as described above with respect to the “Combination of Kim, Hara, and Otsuka,” there was sufficient motivation for a POSITA to apply Hara’s teachings of weight variation to Kim’s electrolytic copper foil and a POSITA would have expected success. SOLUS-1003, ¶79.

Accordingly, in the Kim-Hara-Otsuka combination, the weight deviation of 2% or less falls within the claimed range of weight deviation. These specific weight deviation values taught by Hara and applied to Kim’s copper foil in the combination are thus a relevant disclosure for the recited range of weight deviation values. *See Ineos USA LLC v. Berry Plastics Corp.*, 783 F.3d 865, 869 (Fed. Cir. 2015) (“When a patent claims a range, as in this case, that range is anticipated by a prior art reference if the reference discloses a point within the range”); *Titanium Metals*, 778 F.2d at 782; *In re Petering*, 301 F.2d at 682. Thus, Kim-Hara-Otsuka combination renders obvious the electrolytic copper foil having a weight deviation of 3% or less. SOLUS-1003, ¶80.

[1d]:

The Kim-Hara-Otsuka combination renders obvious [1d]. SOLUS-1003, ¶81. For example, Otsuka teaches an electrolytic copper foil having a **tensile strength** of “*not more than 40 kg[f]/mm²*” and lists examples of tensile strengths such as 32, 36, and 38 kgf/mm² in Table 1, which fall within the teachings of the ’541 patent’s claimed tensile strength range of 30 to 40 kgf/mm². SOLUS-1010, [0020], [0046], Table 1. Additionally, Otsuka describes that the electrolytic copper foil having such tensile strength maintains or enhances adhesion between current collector and active material of the battery, which results in superior “charge/discharge cycle life and productivity” of secondary batteries. *Id.*, Abstract, [0020], [0029], [0030], [0031], [0033]. SOLUS-1003, ¶81.

Therefore, as described above with respect to the Kim-Hara-Otsuka combination, there was sufficient motivation for a POSITA to apply Otsuka’s teachings of tensile strength to Kim’s electrolytic copper foil and a POSITA would have expected success. SOLUS-1003, ¶82.

Accordingly, in the Kim-Hara-Otsuka combination, tensile strength of “not more than 40 kg[f]/mm²” and examples of tensile strengths such as 32, 36, and 38 kgf/mm² described above fall within the claimed tensile strength range of 30 to 40 kgf/mm². These specific tensile strength values disclosed by Otsuka are thus a

relevant disclosure for the recited range of tensile strength values. *See Ineos*, 783 F.3d at 869; *Titanium Metals*, 778 F.2d at 782. SOLUS-1003, ¶83.

Alternatively/additionally, the range of tensile strength (“not more than 40 kg[f]/mm²) for the copper foil of the Kim-Hara-Otsuka combination overlaps with the recited range of tensile strength (30 to 40 kgf/mm²). The ’541 Patent provides no indication of criticality or unexpected results associated with the claimed range of tensile strength. Thus, the overlapping range of tensile strength values of the Kim-Hara-Otsuka combination presents a *prima facie* case of obviousness of the claimed range. *See In re Peterson*, 315 F.3d 1325, 1329 (Fed. Cir. 2003) (“A *prima facie* case of obviousness typically exists when the ranges of a claimed composition overlap the ranges disclosed in the prior art”); *In re Geisler*, 116 F.3d 1465, 1469–70 (Fed. Cir. 1997) (“When an applicant seeks to overcome a *prima facie* case of obviousness by showing improved performance in a range that is within or overlaps with a range disclosed in the prior art, the applicant must “show that the [claimed] range is *critical*, generally by showing that the claimed range achieves unexpected results relative to the *1470 prior art range,” quoting *In re Woodruff*, 919 F.2d 1575, 1578 (Fed. Cir. 1990)); SOLUS-1003, ¶84.

Further, tensile strength of 30 to 40 kgf/mm² indicates a wide range and it was conventional to produce or obtain electrolytic copper foils that fall within, or overlap with, this tensile strength range. SOLUS-1003, ¶85 (citing SOLUS-1023,

Table 2; SOLUS-1028⁷, Table 2, claim 5, [0018], [0050], [0051]). Further, as explained by Dr. Josefowicz, it was conventional to vary the electrolyte concentration, electrolysis plating parameters, temperature, 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. SOLUS-1025, 18, Table 2 (reproduced below); SOLUS-1003, ¶85.

Outstanding Characteristic	Tensile Strength, kg/mm ²	Elongation, % (5cm)	Internal Stress, ^c kg/mm ²	Hardness (VHN ₂₀₀), kg/mm ²	Electrical Resistivity, microhm-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

^aNegative values indicate a compressive stress.
^bDeposits that changed less than 0.02% in length after heating to 400°C.

SOLUS-1025, 18, Table 2

[1e]:

The phrase recited in [1e] should not be given patentable weight. *See* MPEP 2114; *see also* *Hewlett-Packard Co. v. Bausch & Lomb Inc.*, 909 F.2d 1464, 1469

⁷ JP 2007/217787 to Matsuda 787 (SOLUS-1027) was published in Japanese. Thus, all citations to Matsuda 787 are to its English translation (SOLUS-1028).

(Fed. Cir. 1990) (“[A]pparatus claims cover what a device is, not what a device does.”); *In re Swinehart*, 439 F.2d 210, 212 (C.C.P.A. 1971) (Holding that a claim term is functional when it recites a feature “by what it does rather than by what it is”); *In re Gardiner*, 171 F.2d 313, 315-16 (C.C.P.A. 1948) (“It is trite to state the patentability of apparatus claims must be shown in the structure claimed and not merely upon a use, function, or result thereof.”).

However, to the extent that the wrinkle prevention purpose is limiting, the Kim-Hara-Otsuka combination renders obvious [1e] by the Patentee’s own admission. For example, during prosecution of the ’541 Patent, the Patentee 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***.” SOLUS-1002, 35. The Patentee 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).” SOLUS-1002, 37. That is, the Patentee contended that satisfying the structural limitations [1a]-[1d] would allegedly result in the prevention of wrinkles. SOLUS-1002, 36 (“[T]he factors which prevent wrinkles...**are** a texture coefficient ratio, a tensile strength and a weight deviation.”).

As described above, the Kim-Hara-Otsuka combination satisfies “all conditions [or claimed ranges] of the texture coefficient ratio, the tensile strength

and the weight deviation ranges.” Therefore, based on the Patentee’s own admission that limitation [1e] is not an additional requirement imposed by the claims, the Kim-Hara-Otsuka combination renders obvious [1e]. SOLUS-1003, ¶¶86-87; *Alcon Rsch., Ltd. v. Apotex Inc.*, 687 F.3d 1362, 1369 (Fed. Cir. 2012) (Holding that a claimed property “is not an additional requirement imposed by the claims” where patent discloses that it is “a property necessarily present” where other claim limitations are present); *In re Couvaras*, 2023 WL 3984753 (Fed. Cir. June 14, 2023) (“Reciting the mechanism for known compounds to yield a known result cannot overcome a prima facie case of obviousness, even if the nature of that mechanism is unexpected.”).

Alternatively/additionally, to the extent that wrinkle prevention language is limiting, in the combination, Kim and Hara further render obvious this feature. SOLUS-1003, ¶88.

First, a POSITA 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. FIG. 5(b) of Kim illustrates a very smooth surface and the correspondingly measured surface roughness (R_z) is at or below 0.050 μm (50 nm). As explained by Dr. Josefowicz, such a smooth surface is not possible if there are wrinkles on the surface. SOLUS-1003, ¶89.

Second, Hara confirms that the copper foil with an elongation of 5% or less, addresses the wrinkle formation issues to at least some extent. For instance, Hara aims to ensure controlled elongation of Cu foil, which helps prevent the ***formation of wrinkles during the winding process*** and by using Cu foil with minimal weight variability and controlled elongation, the risk of undulation and misalignment, which lead to wrinkles, can be reduced. SOLUS-1009, [0008]. In this regard, Hara focuses on controlling (1) elongation and (2) weight variation, and Hara's teachings are applied to the combination. SOLUS-1003, ¶90.

Third, as explained by Dr. Josefowicz and supported by prior art, tensile strength would have affected both the handleability of copper foil as well as the ***formation of wrinkles*** and other surface defects. For example, “[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.***” SOLUS-1003, ¶91 (citing SOLUS-1014, 2).

Accordingly, to the extent that [1e] is limiting, the Kim-Hara-Otsuka combination render obvious [1e]. SOLUS-1003, ¶92.

[2]:

The Kim-Hara-Otsuka combination renders obvious [2]. SOLUS-1003, ¶93.

As an initial matter, Rz measures the vertical characteristics (e.g., surface

roughness) of the copper foil surface. For example, according to one or more of JIS standards, “Rz” or “Rzjis” corresponds to the 10-point average surface roughness represented as the average of value of the five maximum peak-to-valley heights (e.g., sum of absolute values of the five highest peaks and the absolute values of the five lowest valleys, divided by 5). SOLUS-1003, ¶95 (citing SOLUS-1029, 13, FIG. 4; SOLUS-1030, 24-25). Further, for example, as explained by Dr. Josefowicz, many different standards share the same or similar definition of “Rz.” SOLUS-1003, ¶95 (citing SOLUS-1031, 36; SOLUS-1032).

Kim describes that the copper foil has a *surface roughness* $R_z \approx 0.050 \mu\text{m}$, which falls within the claimed range of “ $2 \mu\text{m}$ or less.” SOLUS-1018, FIGS. 2-4, and Table 1. For example, as described in Table 4 below with annotations, surface roughness R_z at accelerator concentration of 5 ppm, is approximately 50 nm, equivalent to $0.050 \mu\text{m}$. *Id.*, FIG. 4 (reproduced below, annotated). Thus, based on R_z of $0.050 \mu\text{m}$, the Kim-Hara-Otsuka combination, renders obvious [2]. SOLUS-1018, FIGS. 2-4, Table 1; SOLUS-1003, ¶96.

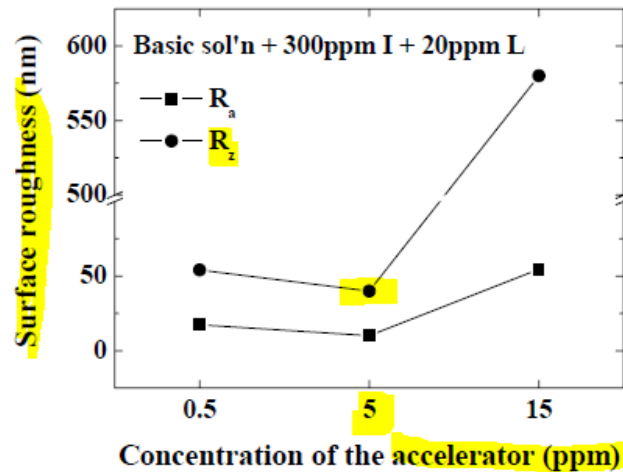


Fig. 4. Surface roughness with the concentration of the accelerator (I: inhibitor, L: leveler, A: accelerator).

SOLUS-1018, FIG. 4 (annotated)

Alternatively/additionally, in the combination, a POSITA would have applied Hara's teachings of R_z values to Kim's copper foil in supplant of Kim's R_z values, which also renders obvious [2]. For example, Hara describes R_z values that fall within the claimed range, along with associated advantages that would have motivated a POSITA to apply Hara's teachings to Kim's copper foil. More specifically, 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.*" SOLUS-1009, [0013], [0051]. Moreover, Hara discloses examples such as "*surface roughness R_z (a ten-point average surface*

roughness) = $1.5\ \mu\text{m}$ ” and cites to a JIS standard. SOLUS-1009, [0031], [0035].
SOLUS-1003, ¶97.

Alternatively/additionally, a POSITA would have applied Otsuka’s teachings of R_z values to Kim’s copper foil in supplant of Kim’s R_z values, which also renders obvious [2]. In particular, Otsuka describes or suggests these features in [2] along with associated advantages. For example, Otsuka describes that “[t]he electrodeposited copper foil has a surface roughness *R_z at a deposition surface at ordinary temperature smaller than $2.5\ \mu\text{m}$ in terms of 10-point average roughness R_z .*” SOLUS-1010, Abstract; *see also* claim 1, [0014], [0020], [0025], [0026], Table 1. Here, the 10-point average roughness R_z is explained by Otsuka as the value measured by a surface roughness meter based on JIS-B-0601. SOLUS-1010, [0014], [0036]; SOLUS-1003, ¶98.

Alternatively/additionally, as Dr. Josefowicz explains, it was indeed common and perhaps conventional knowledge to a POSITA that copper foil with a “surface roughness (R_z - JIS) of $2\ \mu\text{m}$ or less” would be effective for adhesion between the current collector and the active material. For instance, Dr. Josefowicz notes that numerous prior art references teach R_z values of copper foil that anticipate the claimed range of “ $2.0\ \mu\text{m}$ or less,” specifically for use in current collectors of secondary batteries. SOLUS-1003, ¶99 (citing SOLUS-1011, [0012],

[0029]; SOLUS-1017⁸, Abstract, 4, 5; SOLUS-1022, [0018], [0057], [0107]; SOLUS-1023, Abstract, [0012]).

[3]:

The Kim-Hara-Otsuka combination renders obvious [3]. For example, Hara recognizes an elongation rate of 5% or less and provides examples such as 4.8%, describing advantages of such elongation rates including realization of excellent cycle life characteristics of a battery. SOLUS-1009, [0050]; SOLUS-1003, ¶100.

As such, the elongation values of Hara applied to Kim's copper foil in the combination fall within the claimed range of 3 to 20%. *See Ineos*, 783 F.3d at 869; *Titanium Metals*, 778 F.2d at 782; SOLUS-1003, ¶101.

[4]:

The Kim-Hara-Otsuka combination renders obvious [4]. For example, Kim describes that the copper foil used in the study is "**8 μ m thick.**" SOLUS-1018, Abstract, 2; SOLUS-1003, ¶102.

Therefore, in the Kim-Hara-Otsuka combination, Kim's teachings regarding a copper foil having a thickness of 8 μ m falls within the claimed range and thus renders obvious [4]. *See Ineos*, 783 F.3d at 869; *Titanium Metals*, 778 F.2d at 782;

⁸ CN1710737A to Zhang (SOLUS-1016) was published in Chinese. Thus, all citations to Hara are to its English translation (SOLUS-1017).

SOLUS-1003, ¶103.

Alternatively/additionally, Hara describes thickness values that fall within the claimed range, along with associated advantages that would have motivated a POSITA to apply Hara's teachings to Kim's copper foil. More specifically, Hara describes that "it is preferable that the negative electrode current collector has *a thickness of 7 μm to 25 μm* and a surface roughness Rz of 2.0 μm or less."

SOLUS-1009, [0013]. Further, for example, 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.*, [0033]. Hara also describes advantages of such thickness values including realization of excellent cycle life characteristics of a battery. *Id.*, [0051]. Therefore, a POSITA would have applied Hara's teachings of thickness values to Kim's copper foil in supplant of Kim's thickness values, which also renders obvious [4]. SOLUS-1003, ¶104.

V. GROUND 2: Claims 1-4 are obvious over Ye in view of Hara and Otsuka

A. Overview of Ye

Ye describes "electrodeposited copper foils" with the XRD characteristics of

the '541 patent's texture coefficients (TC) ratios. SOLUS-1013, Title; SOLUS-1003, ¶106.

Ye describes that “[a] study was made to correlate different *electrodeposition parameters*, like, *e.g.*, cathodic overpotential, bath composition, and bath ageing, with characteristics as *crystallographic texture and roughness*, and the ductility of electrolytic copper foils.” SOLUS-1013, Abstract. In other words, Ye’s study focuses on understanding how different factors affect the quality of electrolytic copper foils and how the “overpotential” (the extra voltage applied during copper deposition) influences the texture, surface roughness, and flexibility (*e.g.*, ductility) of the copper foils. SOLUS-1013, Abstract; SOLUS-1003, ¶107.

For example, Ye describes that “cracks in printed circuit boards (PCB) are commonly attributed to the low ductility [*e.g.*, elongation] of copper” and that the plating conditions (*e.g.*, mV cathodic overpotential) affect the ductility [*e.g.*, elongation] of copper foil. SOLUS-1013, Abstract. Further, for example, Ye describes that the “cathodic overpotential seems to be the most important controlling parameter” in controlling the crystallographic texture. SOLUS-1013, 2. SOLUS-1003, ¶108.

Moreover, for example, Ye describes that the chloride additive “smoothens the copper coatings,” where its effect “can be seen that most specimens with a roughness factor $\alpha \geq 0.040$ were deposited from solutions containing less than 5

ppm Cl.” *Id.*, 8. Here the roughness factor is “defined as the ratio of the roughness average over the foil thickness.” SOLUS-1013, 2; SOLUS-1003, ¶109.

B. Overview of Hara

See discussion *supra* Part IV.B; SOLUS-1003, ¶110.

C. Overview of Otsuka

See discussion *supra* Part IV.C; SOLUS-1003, ¶111.

D. Combination of Ye, Hara, and Otsuka

It would have been obvious to a POSITA to combine the teachings of Ye, Hara, and Otsuka, the combination of which would render obvious the claimed copper foil of the ’541 patent. SOLUS-1003, ¶112.

As an initial matter, it is not conceded that any modifications to Ye would actually be necessary in order to obtain the copper foils recited in claims 1-4. Ye discloses electrolytic copper foil surface having [1] TC ratios and [2] thickness values that fall within the claimed range of the ’541 Patent. While Ye does not mention [1] weight deviation values, [2] tensile strength values, [3] surface roughness R_z values, and [4] elongation values, **Hara** provides teachings of *weight deviation values*, *R_z values*, and *elongation values* and **Otsuka** provides teachings of *tensile strength values*, *elongation values*, and *R_z values*, which fall within the claimed range of the ’541 Patent. As such, the combination of Ye, Hara, and Otsuka discussed with respect to claims 1-4 should not be taken to indicate any

substantive difference between Ye's copper foil and that recited in the '541 Patent. Rather, 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. SOLUS-1003, ¶113.

At least for the following reasons, it would have been obvious to a POSITA to have combined Ye with Hara and Otsuka, especially as the prior art provides sufficient motivation and guidance for modifying Ye's copper foil to obtain the desired texture coefficients while taking advantage of Hara's disclosed weight deviation of $\leq 2\%$, $R_z \leq 2 \mu\text{m}$, and elongation $\leq 5\%$ and Otsuka's disclosed tensile strength $\leq 40 \text{ kgf/mm}^2$. SOLUS-1003, ¶114.

First, Ye discloses copper foil for use in PCB, which is also compatible for use with secondary batteries. Such use compatibility of electrolytic copper foil between the PCB and the secondary batteries was well-known. SOLUS-1022, [0107]; SOLUS-1023, [0001], [0005], [0012], [0066]; SOLUS-1012, [0010], [0012], [0052]. SOLUS-1003, ¶115.

Second, a POSITA 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. SOLUS-1003, ¶116.

For example, Hara describes that an electrolytic copper foil having “*weight variation per unit area of 2% or less*” and “*elongation of 5% or less*” prevent “the occurrence of spontaneous short circuits” and helps obtaining “a battery with small variation in battery capacity.” SOLUS-1009, [0012], [0063]. Further, for example, Hara describes that “it is preferable that the negative electrode current collector has . . . and *a surface roughness R_z of 2.0 μm or less*” and that “by using electrolytic copper foil with a *weight variation of 2% or less*, a thickness of 10 μm , and *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.*” SOLUS-1009, [0013], [0051]; SOLUS-1003, ¶117.

Moreover, Otsuka, for example, describes that an electrolytic copper foil with tensile strength of “not more than 40 kg[f]/mm²” maintains or enhances adhesion between current collector and active material of the battery, which results in superior “charge/discharge cycle life and productivity” of secondary batteries. SOLUS-1010, Abstract, [0020], [0029], [0030], [0031], [0033]; SOLUS-1003, ¶118.

Therefore, at least for the reasons set forth above, a POSITA would have been motivated to optimize Ye's electrolytic copper foil for use in secondary batteries by applying the exemplary teachings of Hara and Otsuka to optimize

weight deviation, elongation, tensile strength, and Rz values. SOLUS-1003, ¶119.

Further, a POSITA would have expected success at least for the following reasons. SOLUS-1003, ¶120.

First, as described above, since 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 the PCB and secondary batteries was well known, a POSITA would have expected success in applying the teachings of weight deviation, elongation, tensile strength, and Rz values of Hara and Otsuka. SOLUS-1003, ¶121.

Second, as described above, the fact that electrolytic copper foils with weight deviation were commercially available indicates that a POSITA 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. For example, as described above, Hara describes in one of their examples that such electrolytic copper foil with the desired weight deviation of 2% or less is obtained from commercially available suppliers such as “Furukawa Circuit Foil Co., Ltd.” SOLUS-1009, [0027]. Further, Dr. Josefowicz notes that, in regard to use of copper foil for a current collector of a negative electrode of secondary battery, 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. SOLUS-1003, ¶122.

Third, as described above with respect to the Kim-Hara-Otsuka combination, in Ground 1, the optimization of weight deviation, elongation, tensile strength, and Rz values in copper foil would have involved a mere routine optimization of electrodeposition conditions. *See* discussion *supra* Part IV. D; SOLUS-1003, ¶123.

Therefore, a POSITA would have been motivated to apply or optimize weight variation, tensile strength, Rz, and elongation features on Ye's electrolytic copper foil and expected success. *See In re Aller*, 220 F.2d at 456; *see also KSR*, 550 U.S. at 401; *see also Pfizer*, 480 F.3d at 1364. SOLUS-1003, ¶124.

E. Analysis of Claims

[1pre]:

To the extent the preamble is limiting, Ye-Hara-Otsuka renders obvious [1pre]. For example, Ye discloses an electrodeposited copper foil (e.g., electrolytic copper foil) for use in PCB, which is also compatible for use in the current collector of a lithium-ion secondary battery. SOLUS-1013, Abstract. Such use compatibility of electrolytic copper foil between the PCB and the secondary batteries was well-known. SOLUS-1022, [0107]; SOLUS-1023, [0001], [0005], [0012], [0066]; SOLUS-1012, [0010], [0012], [0052]. Therefore, in the combination, Ye discloses a copper foil for a current collector of a lithium

secondary battery. SOLUS-1003, ¶125.

[1a]-[1b]:

The Ye-Hara-Otsuka combination renders obvious [1a]-[1b]. For example, Ye discloses using electrodeposition of copper foils with results of XRD provided in Ye's Table II, reproduced below. SOLUS-1003, ¶126.

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	

SOLUS-1013, Table II (annotated)

As shown in Table II, sample No. 15, Ye discloses measured peak intensity values (“I”) for electrolytic copper foils in the context of a study to correlate certain electrodeposition parameters with characteristics such as “crystallographic texture and roughness, and the ductility” of those electrolytic copper foils. SOLUS-1013, Abstract, 1; SOLUS-1003, ¶127.

By normalizing the measured peak intensity values of Ye using the JCPDS 04-0836 cited in the '541 Patent, the TC values can be calculated for each of the three peaks. The '541 Patent discloses that “JCPDS (Joint Committee for Powder Diffraction Studies) card for standard powder specimens (04-0836) of copper (Cu) [was] used in the Subject invention.” SOLUS-1001, Other Publications.

Accordingly, when calculating TC values using Ye’s copper foil data, JCPDS 04-0836 was used for each $I_0(hkl)$ value, which “represents a standard diffraction intensity of ASTM (American Society of Testing Materials) standard powder-shaped diffraction data,” as recited in [1b]. SOLUS-1003, ¶¶73, 128.

Table 3 Ye TC calculation

Peak	I(hkl)	$I_0(hkl)$	I/I_0	TC(hkl)
(111)	100	100	1	0.94
(200)	52.6	46	1.14	1.07
(220)	21.1	20	1.06	0.99
				3.00

Table 4 Ye TC ratio check

Ratio	Claimed Lower Limit	Value	Claimed Upper Limit
1 st ratio = (111) + (200)	60%	67.0%	85%
2 nd ratio = (111)	18%	31.3%	38%
3 rd ratio = (200)	28%	35.8%	62%
4 th ratio = (220)	15%	33.0%	40%

As shown, the TC and TC ratios regarding sample No. 15 in Ye’s Table 1 are shown in Tables 3 and 4. The example of Ye shown in Table 4 discloses TC ratios that fall within the claimed ranges for all four TC ratios. SOLUS-1003, ¶131.

Thus, in the combination, Ye discloses copper foils within the limits of the ratios of the texture coefficients as recited by the '541 patent, rendering obvious [1a]-[1b]. SOLUS-1003, ¶132.

[1c]:

The Ye-Hara-Otsuka combination renders obvious [1c]. For example, Hara 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 Examples 1 and 2. SOLUS-1009, Abstract, [0011], [0012], [0027], [0029], [0048]; SOLUS-1003, ¶133.

Therefore, in the Ye-Hara-Otsuka combination, the weight deviation of 2% or less falls within the claimed range of weight deviation. These specific weight deviation values taught by Hara and applied to Ye’s copper foil in the combination are thus a relevant disclosure for the recited range of weight deviation values. *See Ineos*, 783 F.3d at 869; *Titanium Metals*, 778 F.2d at 782. Thus, the Ye-Hara-Otsuka combination renders obvious the electrolytic copper foil having a weight deviation of 3% or less. SOLUS-1003, ¶¶134-136.

[1d]:

Ye-Hara-Otsuka renders obvious [1d]. SOLUS-1003, ¶137. For example, Otsuka teaches an electrolytic copper foil having a **tensile strength** of “*not more than 40 kg[f]/mm²*” and lists examples of tensile strengths such as 32, 36, and 38 kgf/mm² in Table 1, which fall within the teachings of the ’541 patent’s claimed tensile strength range of 30 to 40 kgf/mm². SOLUS-1010, [0020], [0046], Table 1.

Accordingly, in the Ye-Hara-Otsuka combination, tensile strength of “not more than 40 kg[f]/mm²” and examples of tensile strengths such as 32, 36, and 38 kgf/mm² described above fall within the claimed tensile strength range of 30 to 40 kgf/mm². These specific tensile strength values disclosed by Otsuka are thus a relevant disclosure for the recited range of tensile strength values. *See Ineos*, 783 F.3d at 869; *Titanium Metals*, 778 F.2d at 782; SOLUS-1003, ¶¶138-140.

Further, tensile strength of *30 to 40 kgf/mm²* indicates a wide range and it was conventional to produce or obtain electrolytic copper foils that fall within, or overlap with, this tensile strength range. SOLUS-1003, ¶141 (citing SOLUS-1023, Table 2; SOLUS-1028, Table 2, claim 5, [0018], [0050], [0051]). Further, as explained by Dr. Josefowicz, it was conventional to vary the electrolyte concentration, electrolysis plating parameters, temperature, the use of organic and inorganic additives, in order to obtain a copper foil with tensile strength falling within the claimed tensile strength range as this range was well known, at least

since 1974, as illustrated below. SOLUS-1025, 18, Table 2 (reproduced below);
SOLUS-1003, ¶141.

Outstanding Characteristic	Tensile Strength, kg/mm ²	Elongation, % (5cm)	Internal Stress, ^c kg/mm ²	Hardness (VHN ₂₀₀), kg/mm ²	Electrical Resistivity, microhm-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

^aNegative values indicate a compressive stress.
^bDeposits that changed less than 0.02% in length after heating to 400°C.

SOLUS-1025, 18, Table 2

[1e]:

The phrase recited in [1e] should not be given patentable weight. *See* MPEP 2114; *see also* *Hewlett-Packard*, 909 F.2d at 1469; *In re Swinehart*, 439 F.2d at 212; *In re Gardiner*, 171 F.2d at 315-16.

However, to the extent that the wrinkle prevention purpose is limiting, the Ye-Hara-Otsuka combination renders obvious [1e] by the Patentee's own admission. For example, during prosecution of the '541 Patent, the Patentee 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*." SOLUS-1002, 35. The Patentee

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).” SOLUS-1002, 37. That is, the Patentee contended that satisfying the structural limitations [1a]-[1d] would allegedly result in the prevention of wrinkles. SOLUS-1002, 36 (“[T]he factors which prevent wrinkles...are a texture coefficient ratio, a tensile strength and a weight deviation.”).

As described above, the Ye-Hara-Otsuka combination satisfies “all conditions [or claimed ranges] of the texture coefficient ratio, the tensile strength and the weight deviation ranges.” Therefore, based on the Patentee’s own admission that limitation [1e] is not an additional requirement imposed by the claims, the Ye-Hara-Otsuka combination renders obvious [1e]. SOLUS-1003, ¶¶142-143; *Alcon*, 687 F.3d at 1369; *In re Couvaras*, 2023 WL 3984753.

Alternatively/additionally, to the extent that wrinkle prevention purpose language is limiting, in the combination, Ye-Hara-Otsuka further renders obvious this feature. SOLUS-1003, ¶144.

First, a POSITA would have understood that Ye describes how the electrodeposition parameters of forming the copper foil are relevant to its texture and ductility and thus also to the likelihood of forming wrinkles. SOLUS-1003, ¶145.

Second, Hara confirms that the copper foil with an elongation of 5% or less, addresses the wrinkle formation issues, as described above with respect to [1e] of Ground 1. *See* discussion *supra* Part IV.E [1e]; SOLUS-1003, ¶146.

Third, as described above with respect to [1e] of Ground 1, tensile strength would have affected both the handleability of copper foil as well as the **formation of wrinkles** and other surface defects. . *See* discussion *supra* Part IV.E [1e]; SOLUS-1003, ¶147.

Accordingly, to the extent that [1e] is limiting, the Ye-Hara-Otsuka combination renders obvious [1e]. SOLUS-1003, ¶148.

[2]:

The Ye-Hara-Otsuka combination renders obvious [2]. For example, Hara describes Rz values that fall within the claimed range, along with associated advantages that would have motivated a POSITA to apply Hara's teachings to Ye's copper foil. More specifically, Hara explains that "it is preferable that the negative electrode current collector has . . . *a surface roughness Rz of 2.0 μ m or less*" and that "by using electrolytic copper foil with . . . *a surface roughness of Rz of 2.0 μ m or less* in the negative electrode current collector, a battery with *excellent cycle life characteristics can be realized.*" SOLUS-1009, [0013], [0051]. Moreover, Hara discloses examples such as "*surface roughness Rz (a ten-point average*

surface roughness) = $1.5\ \mu\text{m}$ ” and cites to a JIS standard. SOLUS-1009, [0031], [0035]. SOLUS-1003, ¶149.

Therefore, as described above with respect to the Ye-Hara-Otsuka combination, there was sufficient motivation for a POSITA to apply Hara’s teachings of Rz values to Ye’s copper foil and a POSITA would have expected success. SOLUS-1003, ¶150.

Accordingly, in the Ye-Hara-Otsuka combination, “*a surface roughness Rz of $2.0\ \mu\text{m}$ or less*” equates to the claimed range of “ $2\ \mu\text{m}$ or less.” These specific Rz values, as taught by Hara and applied to the combination, are thus a relevant disclosure for the recited range of Rz values. *See Ineos*, 783 F.3d at 869; *Titanium Metals*, 778 F.2d at 782; SOLUS-1003, ¶151.

Alternatively/additionally, a POSITA would have applied Otsuka’s teachings of Rz values to Ye’s copper foil in supplant of Hara’s Rz values, which also renders obvious [2]. In particular, Otsuka describes or suggests these features along with associated advantages. For example, Otsuka describes that “[t]he electrodeposited copper foil has a surface roughness *Rz at a deposition surface at ordinary temperature smaller than $2.5\ \mu\text{m}$ in terms of 10-point average roughness Rz*.” SOLUS-1010, Abstract; *see also* claim 1, [0014], [0020], [0025], [0026]. Here, the 10-point average roughness Rz is explained by Otsuka as the value measured by a surface roughness meter based on JIS-B-0601. SOLUS-1010,

[0014], [0036]; SOLUS-1003, ¶152.

Alternatively/additionally, as Dr. Josefowicz explains, it was indeed common and perhaps conventional knowledge to a POSITA that copper foil with a “surface roughness (Rz - JIS) of 2 µm or less” would be effective for adhesion between the current collector and the active material. For instance, Dr. Josefowicz notes that numerous prior art references teach Rz values of copper foil that anticipate the claimed range of “2.0 µm or less,” specifically for use in current collectors of secondary batteries. SOLUS-1003, ¶153 (citing SOLUS-1011, [0012], [0029]; SOLUS-1022, [0018], [0057], [0107]; SOLUS-2023, Abstract, [0012]).

[3]:

In the Ye-Hara-Otsuka combination, Hara renders obvious [3]. For example, Hara recognizes an elongation rate of 5% or less and provides examples such as 4.8%, describing advantages of such elongation rate including realization of excellent cycle life characteristics of a battery. SOLUS-1009, [0031], [0050]; SOLUS-1003, ¶154.

Therefore, the elongation values of Hara applied to Ye’s copper foil in the combination fall within the claimed ranges of 3 to 20%. *See Ineos*, 783 F.3d at 869; *Titanium Metals*, 778 F.2d at 782; SOLUS-1003, ¶155.

[4]:

In the combination, Ye renders obvious [4]. For example, Ye's table I, reproduced below illustrates electrodeposited copper foils, including sample No. 15, with thicknesses between 17.7 and 22.3 μm . SOLUS-1013, 3, Table I (reproduced below, annotated); SOLUS-1003, ¶156.

Table I. Electrodeposition conditions, ductility, roughness, thickness, and morphology type for specimens tested.

No.	η (mV)	Current density (A/dm ²)	Cl ⁻ (ppm)	Pretreatment	Morphology	t	Penetration depth (mm)	h_0 (μm)	R_a (μm)	α
1	87	0.47	5	yes	b	S	1.07	19.7	0.36	0.019
2	87	0.44	5	yes	b	L	0.96	19.4	0.60	0.031
3	87	0.44	5	yes	b	S	0.99	18.5	0.50	0.027
4	87	0.45	5	yes	b	S	1.02	19.7	0.63	0.032
5	87	0.47	5	yes	b	S	1.04	20.9	0.55	0.026
6	87	0.47	25	yes	b	S	0.97	20.4	0.51	0.025
7	113	0.80	5	yes	d	L	0.87	17.7	0.75	0.042
8	113	0.66	5	yes	b	L	1.02	20.3	0.48	0.022
9	113	0.60	5	yes	b	S	1.03	20.4	0.68	0.033
10	113	0.60	5	yes	b	L	1.01	20.6	0.65	0.032
11	113	0.66	5	yes	b	S	1.01	20.1	0.79	0.039
12	113	1.10	5	yes	b	S	0.93	20.4	0.70	0.034
13	113	0.90	5	yes	b	L	0.82	22.3	1.85	0.083
14	113	0.70	10	yes	b	L	0.95	19.8	0.84	0.042
15	113	0.80	15	yes	b	L	0.93	20.5	0.68	0.033
16	113	0.90	0	no	b	S	0.92	20.1	0.81	0.040
17	113	0.70	5	no	b	S	1.06	21.1	0.58	0.027
18	113	0.90	10	no	b	S	1.09	21.0	0.38	0.018
19	120	1.10	0	no	b	L	0.97	21.4	0.60	0.028
20	120	1.10	0	no	b	S	0.93	21.7	0.59	0.027
21	120	0.70	5	no	b	S	1.06	19.9	0.42	0.021
22	120	0.70	10	no	b	L	1.02	20.9	0.38	0.018
23	120	0.85	20	no	b	S	0.90	19.4	0.37	0.019
24	120	0.81	20	no	b	S	0.93	19.7	0.60	0.031
25	158	1.00	5	yes	b	S	1.00	20.5	0.57	0.028
26	158	1.46	5	yes	d	L	0.81	21.3	1.73	0.081
27	158	1.18	5	yes	b	S	0.95	20.1	0.36	0.018
28	158	0.90	5	yes	b	L	0.95	21.9	1.31	0.060
29	200	1.27	5	yes	b	S	0.97	19.8	0.42	0.021
30	200	1.93	5	yes	b	L	0.96	20.1	0.87	0.043
31	200	1.70	20	no	a	S	0.90	21.8	0.48	0.022
32	250	3.30	0	no	c	L	0.84	20.7	0.62	0.030
33	250	3.20	0	no	c	L	0.83	19.1	0.36	0.019
34	250	3.20	0	no	c	S	0.72	20.8	0.91	0.044
35	250	2.90	5	no	a	S	0.63	19.0	0.41	0.021
36	250	3.10	10	no	a	S	0.61	19.8	0.58	0.029
37	250	3.30	20	no	a	L	0.76	19.8	0.48	0.024
38	250	3.20	20	no	a	L	0.72	21.1	0.78	0.037
39	250	2.90	20	no	a	S	0.60	20.2	0.38	0.019
40	250	3.30	40	no	a	S	0.53	19.7	0.39	0.020
41	250	3.30	5	yes	c	S	0.74	21.5	1.16	0.054
42	250	3.10	10	yes	a	S	0.70	21.0	0.93	0.044
43	250	3.10	15	yes	a	S	0.70	22.1	1.43	0.065
44	250	3.00	25	yes	a	L	0.53	19.2	0.42	0.022

Note: η , overpotential, t, ageing time of solution, (L for a long time and S for a short time); h_0 , thickness; R_a , average roughness; α , roughness factor.

SOLUS-1013, Table I (annotated)

Alternatively/additionally, Hara describes thickness values that fall within the claimed range, along with associated advantages that would have motivated a POSITA to apply Hara's teachings to Ye's copper foil. More specifically, Hara describes that "it is preferable that the negative electrode current collector has *a thickness of 7 μm to 25 μm* and a surface roughness Rz of 2.0 μm or less." SOLUS-1009, [0013]. Further, for example, 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.*" SOLUS-1009, [0033]. Hara also describes advantages of such thickness values including realization of excellent cycle life characteristics of a battery. *Id.*, [0051]. Therefore, a POSITA would have applied Hara's teachings of thickness values to Ye's copper foil in supplant to Ye's thickness values, which also renders obvious [4]. SOLUS-1003, ¶157.

VI. GROUND 3: Claims 1-4 are obvious over Hirose in view of Hara and Otsuka or Matsuda

A. Overview of Hirose

Hirose describes copper foils for use as an anode of a battery. For example, Hirose "The present invention relates to *a current collector containing copper,*

and an anode and a battery using it.” SOLUS-1007, [0003]; SOLUS-1003, ¶159.

Hirose’s motivation is that “in the invention, it is desirable to provide *a current collector, an anode, and a battery capable of improving the cycle characteristics.*” SOLUS-1007, [0011]; SOLUS-1003, ¶160.

Three ways in which Hirose improves battery cycle characteristics are (1) improving the contact characteristics of the current collector to the active material, (2) maintaining a high discharge capacity retention ratio, and (3) preventing a short circuit between the anode and the cathode. *See* SOLUS-1007, [0015], [0047], [0101], [0116], [0119], [0153]; SOLUS-1003, ¶161.

Moreover, in regard to wrinkle formation, Hirose describes that “[i]n the case that the extension coefficient is larger than 10%, a wrinkle may be generated in the anode current collector 1 when the anode active material layer 2 is expanded and shrunk.” SOLUS-1007, [0049]; SOLUS-1003, ¶162.

B. Overview of Hara

See discussion *supra* Part IV.B. SOLUS-1003, ¶163.

C. Overview of Otsuka

See discussion *supra* Part IV.C. SOLUS-1003, ¶164.

D. Overview of Matsuda

Matsuda describes “*an electrodeposited copper foil* which has a lower profile and a higher gloss than low-profile electrodeposited copper foil

conventionally supplied in markets.” SOLUS-1012, Abstract. “Particularly, the present invention relates to an electrodeposited copper foil of which the bonding surface to an insulating layer-forming material has a low profile and a high gloss.” *Id.*, [0001]; SOLUS-1003, ¶165.

In addition, Matsuda seeks to use “copper foils as *negative electrode current collectors for lithium ion batteries*, the copper foils having the *smooth surface are preferably* used.” SOLUS-1012, [0012]; SOLUS-1003, ¶166.

Matsuda uses several variations of the chemical concentrations and other process parameters (e.g., bath temperature and current density) to achieve the desired surface and materials characteristics of the copper foils. SOLUS-1012, [0026]-[0031], [0062], [0063], [0066], [0070], ; SOLUS-1003, ¶167.

E. Combination of Hirose, Hara, and Otsuka or Matsuda

It would have been obvious to a POSITA to combine the teachings of Hirose, Hara, and Otsuka or Matsuda, the combination of which would render obvious the claimed copper foil of the ’541 patent. SOLUS-1003, ¶168.

As an initial matter, it is not conceded that any modifications to Hirose would actually be necessary in order to obtain the copper foils recited in claims 1-4. Hirose discloses electrolytic copper foil surface having [1] TC ratios, [2] Rz values, and [3] thickness values that fall within the claimed ranges of the ’541

Patent. While Hirose does not mention [1] weight deviation values, [2] tensile strength values, and [3] elongation values, **Hara** provides teachings of *weight deviation values* and *elongation values* and **Otsuka or Matsuda** provides teachings of *tensile strength values*, which fall within the claimed ranges of the '541 Patent. As such, 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. Rather, 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. SOLUS-1003, ¶169.

At least for the following reasons, it would have been obvious to a POSITA to have combined Hirose with Hara and Otsuka (or Matsuda), especially as the prior art provides sufficient motivation and guidance for modifying Hirose's copper foil to obtain the desired texture coefficients while taking advantage of Hara's disclosed weight deviation of $\leq 2\%$, $R_z \leq 2 \mu\text{m}$, and elongation $\leq 5\%$ and Otsuka's disclosed tensile strength $\leq 40 \text{ kgf/mm}^2$ or Matsuda's disclosed tensile strength of $\geq 33 \text{ kgf/mm}^2$. SOLUS-1003, ¶170.

First, 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. SOLUS-1009, Abstract, [0011], [0012]; SOLUS-1010, [0002], [0003], [0011]-[0018]; SOLUS-1007, [0116], [0153]-[0155]; SOLUS-1012, [0012]; SOLUS-1003, ¶171.

Second, a POSITA 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. SOLUS-1003, ¶172.

For example, Hara describes that an electrolytic copper foil having “***weight variation per unit area of 2% or less***” and “***elongation of 5% or less***” prevent “the occurrence of spontaneous short circuits” and helps obtaining “a battery with small variation in battery capacity.” SOLUS-1009, [0012], [0063]. Further, for example, Hara describes that “it is preferable that the negative electrode current collector has . . . and ***a surface roughness R_z of 2.0 μm or less***” and that “by using electrolytic copper foil with a ***weight variation of 2% or less***, a thickness of 10 μm , and ***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.*, [0013], [0051]; SOLUS-1003, ¶173.

Moreover, Otsuka, for example, describes that an electrolytic copper foil

with tensile strength of “not more than 40 kg[f]/mm²” 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. SOLUS-1010, Abstract, [0020], [0029], [0030], [0031], [0033]; SOLUS-1003, ¶174.

Further, Matsuda, for example, describes that in order to prevent breakage of the current collector upon repeated expansion/contraction, “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” and presents “tensile strength of not less than 33 kgf/mm² and an elongation of not less than 5%.” SOLUS-1012, [0012], [0019], [0020]; SOLUS-1003, ¶175.

Therefore, at least for the reasons set forth above, a POSITA would have been motivated to optimize Hirose’s electrolytic copper foil for use in secondary batteries by applying the exemplary teachings of Hara and Otsuka (or Matsuda) to optimize weight deviation, elongation, and tensile strength. SOLUS-1003, ¶176.

Further, a POSITA would have expected success at least for the following reasons. SOLUS-1003, ¶177.

First, as described above, since all of the above-noted references focus on providing electrolytic copper foil for use in lithium-ion secondary batteries, a

POSITA would have expected success in applying the teachings of weight deviation, elongation, and tensile strength values of Hara and Otsuka (or Matsuda). SOLUS-1003, ¶178.

Second, as described above, the fact that electrolytic copper foils with weight deviation were commercially available indicates that a POSITA 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. For example, as described above, Hara describes in one of their examples that such electrolytic copper foil with the desired weight deviation of 2% or less is obtained from commercially available suppliers such as “Furukawa Circuit Foil Co., Ltd.” SOLUS-1009, [0027]. Further, Dr. Josefowicz notes that, in regard to use of copper foil for a current collector of a negative electrode of secondary battery, 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. SOLUS-1003, ¶179.

Third, as described above with respect to the Kim-Hara-Otsuka combination in Ground 1, the optimization of weight deviation, elongation, tensile strength, and Rz values in copper foil would have involved a mere routine optimization of electrodeposition conditions. *See* discussion *supra* Part IV. D; SOLUS-1003, ¶180.

Further, as explained by Dr. Josefowicz, a POSITA would have known to optimize weight deviation, elongation, tensile strength, Rz values, and TC ratios. Dr. Josefowicz explains that “[i]n an example, Hirose Table 1, along with numerous other data from Hirose, discloses that intensity values (and thus TC ratios) can be varied while keeping surface roughness characteristics and thickness of copper foil constant. This was achieved, for instance, by varying the annealing temperatures or through controlled heating of the copper current collector.” SOLUS-1007, [0150]–[0153]; SOLUS-1003, ¶180.

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, microhm-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

^aNegative values indicate a compressive stress.
^bDeposits that changed less than 0.02% in length after heating to 400°C.

SOLUS-1025, 18, Table 2

Therefore, a POSITA would have been motivated to apply or optimize weight variation, tensile strength, and elongation features on Hirose’s electrolytic copper foil and expected success. *See In re Aller*, 220 F.2d at 456; *see also KSR*, 550 U.S. at 401; *see also Pfizer*, 480 F.3d at 1364. SOLUS-1003, ¶181.

F. Analysis of Claims

[1pre]:

To the extent the preamble is limiting, the copper foil discussed in Hirose satisfies or at least renders obvious an electrolytic copper foil. For example, Hirose describes copper foil, such as “electrolytic copper foil” for a current collector of a lithium secondary battery. SOLUS-1007, [0010], [0052], [0085], [0090], [0145]; SOLUS-1003, ¶182.

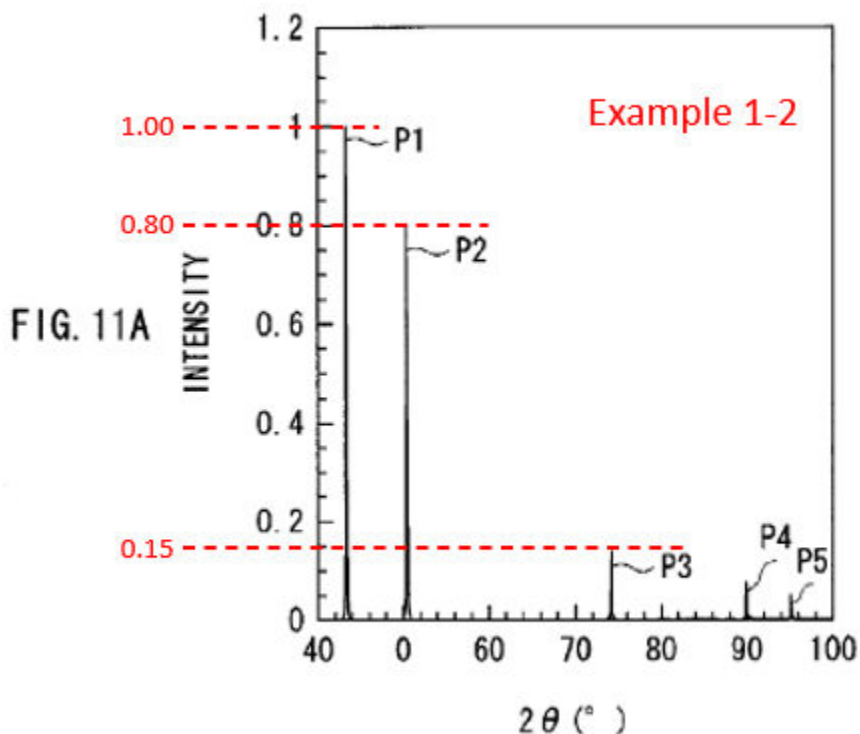
[1a]-[1b]:

In the combination, Hirose renders obvious [1a]-[1b]. SOLUS-1003, ¶183.

Hirose explains that “[a]s a representative of Examples 1-1 to 1-7 described above, when the anodes 54 used for the secondary batteries of *Examples 1-2 and 1-4 were analyzed by an XRD device, the results shown in FIGS. 11A and 11B were obtained. FIG. 11A and FIG. 11B respectively show Examples 1-2 and 1-4.*” SOLUS-1007, [0155]. SOLUS-1003, ¶184.

FIGS. 11A and 11B of Hirose, which correspond to Example 1-2 and Example 1-4 of Hirose, respectively, are reproduced below with annotations in red to show the values of the peaks of the X-ray diffraction measurements for the two samples. Further, based on FIGS. 11A and 11B of Hirose, below Tables 5-8 have

been developed to better illustrate the TC and TC ratios. SOLUS-1003, ¶185.



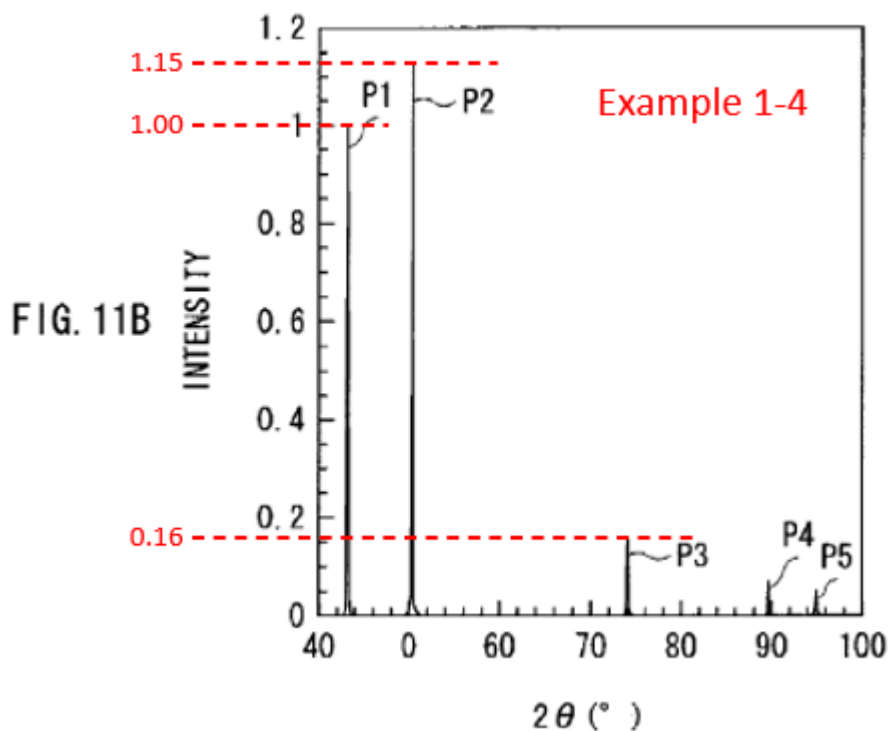
SOLUS-1007, FIG. 11A with annotations in red.

Table 5 Hirose Example 1-2 TC calculation

Peak	I(hkl)	I ₀ (hkl)	I/I ₀	TC(hkl)
P1 = (111)	1.00	100	0.0100	0.86
P2 = (200)	0.80	46	0.0174	1.50
P3 = (220)	0.15	20	0.0075	<u>0.64</u>
				3.00

Table 6 Hirose Example 1-2 TC ratio check

Ratio	Claimed Lower Limit	Value	Claimed Upper Limit
1 st ratio = (111) + (200)	60%	78.5%	85%
2 nd ratio = (111)	18%	28.7%	38%
3 rd ratio = (200)	28%	49.8%	62%
4 th ratio = (220)	15%	21.5%	40%



SOLUS-1007, FIG. 11B with annotations in red.

Table 7 Hirose Example 1-4 TC calculation

Peak	I(hkl)	I ₀ (hkl)	I/I ₀	TC(hkl)
P1 = (111)	1	100	0.0100	0.70
P2 = (200)	1.15	46	0.0250	1.74
P3 = (220)	0.16	20	0.0080	<u>0.56</u>
				3.00

Table 8 Hirose Example 1-4 TC ratio check

Ratio	Claimed Lower Limit	Value	Claimed Upper Limit
1 st ratio = (111) + (200)	60%	81.4%	85%
2 nd ratio = (111)	18%	23.3%	38%
3 rd ratio = (200)	28%	58.1%	62%
4 th ratio = (220)	15%	18.6%	40%

As described above, Table 6 and Table 8 show that Hirose's electrolytic copper foils satisfy the claimed TC ratios of the '541 patent. Therefore, based on Hirose's copper foils having the TC ratios that satisfy [1a]-[1b], the Hirose-Hara-Otsuka/Matsuda combination renders obvious [1a]-[1b]. SOLUS-1003, ¶190.

[1c]:

The Hirose-Hara-Otsuka/Matsuda combination renders obvious [1c]. For example, Hara discloses 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 Examples 1 and 2. SOLUS-1009, Abstract, [0011], [0012], [0015], [0027], [0029], [0048]; SOLUS-1003, ¶191.

Accordingly, in the combination, the weight deviation of 2% or less, as taught by Hara and applied to Hirose's copper foil, falls within the claimed range of weight deviation. These specific weight deviation values disclosed by Hara are thus a relevant disclosure for the recited range of weight deviation values. *See Ineos*, 783 F.3d at 869; *Titanium Metals*, 778 F.2d at 782. Thus, the Hirose-Hara-Otsuka/Matsuda combination renders obvious the electrolytic copper foil having a weight deviation of 3% or less. SOLUS-1003, ¶192.

[1d]:

In the combination, Otsuka or Matsuda renders obvious [1d]. SOLUS-1003, ¶193.

First, Otsuka teaches an electrolytic copper foil having a **tensile strength** of “*not more than 40 kg[f]/mm²*” and lists examples of tensile strengths such as 32, 36, and 38 kgf/mm² in Table 1, which fall within the teachings of the ’541 patent’s claimed tensile strength range of 30 to 40 kgf/mm². SOLUS-1010, [0020], [0046], Table 1. Additionally, Otsuka describes that the electrolytic copper foil having such tensile strength maintains or enhances adhesion between current collector and active material of the battery, which results in superior “charge/discharge cycle life and productivity” of secondary batteries. SOLUS-1010, Abstract, [0020], [0029], [0030], [0031], [0033]; SOLUS-1003, ¶194.

Accordingly, in the Hirose-Hara-Otsuka/Matsuda combination, tensile strength of “not more than 40 kg[f]/mm²” and examples of tensile strengths such as 32, 36, and 38 kgf/mm² described above fall within the claimed tensile strength range of 30 to 40 kgf/mm². Thus, these specific tensile strength values disclosed by Otsuka and applied to Hirose’s copper foil in the combination renders obvious [1d]. SOLUS-1003, ¶195.

Second, Matsuda explains that “in order to prevent breakage of current collector upon repeated expansion/contraction, “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” and presents “***tensile strength of not less than 33 kgf/mm²*** and an elongation of not less than 5%.” SOLUS-1012, [0012], [0019], [0020]; SOLUS-1003, ¶196.

Therefore, in the Hirose-Hara-Otsuka/Matsuda combination, the tensile strength of not less than 33 kgf/mm² taught by Matsuda and applied to Hirose’s copper foil also renders obvious [1d]. SOLUS-1003, ¶197.

[1e]:

The phrase recited in [1e] should not be given patentable weight. *See* MPEP 2114; *see also* *Hewlett-Packard*, 909 F.2d at 1469; *In re Swinehart*, 439 F.2d at 212; *In re Gardiner*, 171 F.2d at 315-16.

However, to the extent that the wrinkle prevention purpose is limiting, the Hirose-Hara-Otsuka/Matsuda combination renders obvious [1e] by the Patentee’s own admission. For example, during prosecution of the ’541 Patent, the Patentee 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**.” SOLUS-1002, 35. The Patentee 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).” SOLUS-1002, 37. That is, the Patentee contended that satisfying the structural limitations [1a]-[1d] would allegedly result in the prevention of wrinkles. SOLUS-1002, 36 (“[T]he factors which prevent wrinkles...are a texture coefficient ratio, a tensile strength and a weight deviation.”).

As described above, the Hirose-Hara-Otsuka/Matsuda combination satisfies “all conditions [or claimed ranges] of the texture coefficient ratio, the tensile strength and the weight deviation ranges.” Therefore, based on the Patentee’s own admission that limitation [1e] is not an additional requirement imposed by the claims, the Hirose-Hara-Otsuka/Matsuda combination renders obvious [1e]. SOLUS-1003, ¶¶198-199; *Alcon*, 687 F.3d at 1369; *In re Couvaras*, 2023 WL 3984753.

Alternatively/additionally, to the extent that wrinkle prevention purpose language is limiting, in the combination, Hirose-Hara-Otsuka/Matsuda further renders obvious this feature. SOLUS-1003, ¶200.

First, a POSITA would have understood that Hirose describes how the electrodeposition parameters of forming the copper foil are relevant to its texture and ductility and thus also to the likelihood of forming wrinkles. SOLUS-1003, ¶201.

Second, Hara confirms that the copper foil with an elongation of 5% or less, addresses the wrinkle formation issues, as described above with respect to [1e] of Ground 1. *See* discussion *supra* Part IV.E [1e]; SOLUS-1003, ¶202.

Third, as described above with respect to [1e] of Ground 1, tensile strength would have affected both the handleability of copper foil as well as the **formation of wrinkles** and other surface defects. *See* discussion *supra* Part IV.E [1e]; SOLUS-1003, ¶203.

Accordingly, to the extent that [1e] is limiting, the Hirose-Hara-Otsuka/Matsuda combination renders obvious [1e]. SOLUS-1003, ¶204.

[2]:

In the Hirose-Hara-Otsuka/Matsuda combination, Hirose renders obvious [2]. For example, Hirose describes that the “[t]en point height of roughness profile Rz of the surface of the anode current collector 1 is preferably in ***the range from 1.5 μ m to 5.5 μ m***” and that “The definition of the ten point height of roughness profile Rz is based on JIS B 0601.” SOLUS-1007, [0051], [0086], FIG. 16. Thus, the range of Rz values (***1.5-5.5 μ m***) for the copper foil of the Hirose-Hara-Otsuka/Matsuda combination overlaps with the recited range of Rz values (***2 μ m or less***). Moreover, the ’541 Patent provides no discussion or evidence of unexpected results or criticality associated with copper foils having Rz values

within the claimed range. Thus, based on the overlapping range disclosed by Hirose, Hirose-Hara-Otsuka/Matsuda combination presents a *prima facie* case and renders obvious the recited range of Rz values. See *In re Peterson*, 315 F.3d at 1329; *In re Geisler*, 116 F.3d at 1469–70; SOLUS-1003, ¶205.

Alternatively/additionally, in the combination, a POSITA would have applied Hara’s teachings of Rz values to Hirose’s copper foil in supplant of Hirose’s Rz values, which also renders obvious [2]. For example, Hara describes Rz values that fall within the claimed range, along with associated advantages that would have motivated a POSITA to apply Hara’s teachings to Hirose’s copper foil. More specifically, 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.*” SOLUS-1009, [0013], [0051]. Moreover, Hara discloses examples such as “*surface roughness R_z (a ten-point average surface roughness) = 1.5 μm* ” and cites to a JIS standard. SOLUS-1009, [0031], [0035]; SOLUS-1003, ¶206.

Alternatively/additionally, as Dr. Josefowicz explains, it was indeed common and perhaps conventional knowledge to a POSITA 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. For instance, Dr. Josefowicz notes that numerous prior art references teach Rz values of copper foil that anticipate the claimed range of “2.0 μm or less,” specifically for use in current collectors of secondary batteries. SOLUS-1003, 207 (citing SOLUS-1011, [0012], [0029]; SOLUS-1022, [0018], [0057], [0107]; SOLUS-2023, Abstract, [0012]).

Thus, Hirose-Hara-Otsuka/Matsuda combination renders obvious [2].
SOLUS-1003, ¶208.

[3]:

In the Hirose-Hara-Otsuka/Matsuda combination, Hara renders obvious [3]. For example, Hara recognizes an elongation rate of 5% or less and provides examples such as 4.8%, describing advantages of such elongation rate including realization of excellent cycle life characteristics of a battery. SOLUS-1009, [0031], [0050]; SOLUS-1003, ¶209.

Therefore, the elongation values applied to Hirose’s copper foil in the combination fall within the claimed range of 3 to 20%. *See Ineos*, 783 F.3d at 869; *Titanium Metals*, 778 F.2d at 782; SOLUS-1003, ¶210.

Alternatively/additionally, the range of elongation (**5% of less**) for the copper foil of the Hirose-Hara-Otsuka/Matsuda combination overlaps with the recited range of elongation (**3 to 20%**). The ’541 Patent provides no discussion or

evidence of unexpected results or criticality associated with copper foils having an elongation within the claimed range. Thus, based on the overlapping range disclosed by Hirose, the Hirose-Hara-Otsuka/Matsuda combination presents a *prima facie* case and renders obvious the recited range of elongation. *See In re Peterson*, 315 F.3d at 1329; *In re Geisler*, 116 F.3d at 1469–70; SOLUS-1003, ¶211.

[4]:

The Hirose-Hara-Otsuka/Matsuda combination renders obvious [4]. For example, Hirose describes that “The *thickness of the original foil 1A is preferably in the range from 10 μ m to 25 μ m,*” with the thickness values falling within the claimed range. SOLUS-1007, [0053], [0084], [0086], [0144]-[0145]; SOLUS-1003, ¶212.

Thus, based on the exemplary thickness values disclosed by Hirose, Hirose-Hara-Otsuka/Matsuda combination renders obvious [4]. *See Ineos*, 783 F.3d at 869; *Titanium Metals*, 778 F.2d at 782; SOLUS-1003, ¶213.

VII. SECONDARY CONSIDERATIONS

Petitioner is unaware of any secondary considerations evidence that would affect, let alone overcome, the strong case of obviousness set forth above. To the

extent Patent Owner subsequently presents such evidence, Petitioner respectfully requests the right to respond.

VIII. PTAB DISCRETION SHOULD NOT PRECLUDE INSTITUTION

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

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

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

Factor 2 is neutral based on an expected Final Written Decision (FWD) date in April 2026, which is within five months of the currently scheduled trial date of November 3, 2025. *See* SOLUS-1038. Additionally, Solus's Motion to Transfer filed on June 12, 2024, if successful, will help ensure that the FWD outpaces any trial date, based on the actual schedule or the median time-to-trial. *See* SOLUS-1039. Moreover, this petition is being filed just over four months after the complaint was amended to add the '541 Patent, further demonstrating Petitioner's great diligence. SOLUS-1037.

Factor 3 favors institution; Petitioner has diligently filed this Petition just over four months after the '541 Patent was asserted by Patent Owner, and the

EDTX litigation is still in its early stages and the parties and the court have yet to expend significant resources on invalidity.

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

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

Factor 6 favors institution; the Petition presents a compelling case of invalidity. Among other things, as further detailed *infra*, the wrinkle prevention limitation of claim 1, which ultimately led to allowance, should not be given patentable weight based at least on the Patentee's characterization of the same during prosecution as merely an aspirational byproduct of satisfying the other numerical ranges of claim 1.

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

The grounds advanced in this Petition are based on six prior art references: Hirose, Hara, Otsuka, Ye, Matsuda, and Kim. Four of the six references—namely, Hara, Otsuka, Ye, and Kim—that make up Grounds 1 and 2 were neither cited nor relied upon during prosecution of the '541 Patent. *See* LGES-1002, 118-131. Although a combination involving Hirose and Matsuda was relied upon during prosecution for some of the rejections, discretionary denial based on this fact is improper under *Advanced Bionics*.

Indeed, under 35 U.S.C. § 325(d), the Board uses a two-part framework in determining whether to exercise its discretion to institute. *Advanced Bionics, LLC v. MED-EL Elektromedizinische Geräte GmbH*, IPR2019-01469, Paper 6, 8 (PTAB Feb. 13, 2020) (precedential) (“*Advanced Bionics*”). First, the Board considers “whether the same or substantially the same art previously was presented to the Office or whether the same or substantially the same arguments previously were presented to the Office.” *Id.* When either condition of the first part of the framework is satisfied, the Board next considers “whether the petitioner has demonstrated that the Office erred in a manner material to the patentability of challenged claims.” *Id.*

In applying this framework, the Board evaluates six factors (“the *Becton* factors”). *Id.*, 8-10 (citing *Becton, Dickinson & Co. v. B. Braun Melsungen AG*, IPR2017-01586, Paper 8 (PTAB Dec. 15, 2017) (precedential as to § III.C.5, first paragraph) (“*Becton*”); see Trial Practice Guide July 2019 Update, 28-31, Fed. Reg. 33,925 (July 16, 2019). These factors are known as the Becton factors (a) through (f). *Advanced Bionics* at 9, n.10 (citing *Becton*). As discussed below, the *Becton* factors favor institution.

Becton factors (a), (b), (c), and (d) support institution because this Petition does not present substantially the same prior art combinations or arguments that were before the Office during examination of the ’541 Patent. As noted above,

none of the references that make up Grounds 1 and 2 were cited during prosecution. Though Hirose and Matsuda were cited, neither Hara nor Otsuka (which are combined with Hirose in Ground 3) were considered, and thus the combinations as set forth in this Petition are not cumulative of those considered during prosecution.

Although Petitioner believes that part 1 of the *Advanced Bionics* framework is not satisfied for the reasons above, it is further and nevertheless contended that part 2 is also not satisfied, and further that *Becton* factors (e) and (f) favor Petitioner because the Office erred in its evaluation of Hirose and because evidence presented above warrant reconsideration of said evaluation.

Specifically, as noted *supra*, the underlying application to the '541 Patent was only allowed after the Patentee added intended use-type language “so as to prevent the generation of wrinkles at a surface of the copper foil” to claim 1. SOLUS-1002, 21. This allowance was based in part on the Patentee’s incorrect assertion that the prior art must somehow expressly recognize the texture coefficient ratio to be “an important factor in relation to the generation of wrinkles” to satisfy the limitations of claim 1. *Id.*, 34; *see also id.*, 21 (Examiner explaining the reason for allowance by noting that “[t]he prior art...does not teach or suggest a copper foil having the claimed texture coefficients ***so as to prevent wrinkle generation.***”); *Endo Pharm. Sols., Inc. v. Custopharm Inc.*, 894 F.3d 1374,

1381 (Fed. Cir. 2018) (“An inherent characteristic of a formulation can be part of the prior art in an obviousness analysis even if the inherent characteristic was unrecognized or unappreciated by a skilled artisan.”).

However, the examiner overlooked the fact that there is nothing in the specification or prosecution history to indicate that anything beyond the structural limitations (*i.e.*, [1a]-[1d]) contribute to wrinkle prevention. In fact, the Patentee admitted as much in (i) merely hypothesizing that “applicant’s data...***may support*** a conclusion that the precise confluence of texture coefficients, tensile strength and weight deviation has critical significance to the prevention of wrinkles” and (ii) strictly equating the structural limitations [1a]-[1d] to the prevention of wrinkles. *Id.*, 35-35 (Telling the Examiner that “Examples 1-7 [of the ’541 Patent] satisfy the numerical ranges of all conditions, defined in claim 1 of this application, ***thereby preventing wrinkles.***”).

In short, by not considering the new references and combinations based on the same as advanced in this Petition and by further failing to recognize that the wrinkle prevention limitation is merely one of intended result that should not be given patentable weight based on the Patentee’s admission, the examiner erred in the evaluation of the prior art, thus warranting reconsideration.

IX. CONCLUSION AND FEES

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

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

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

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

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

Petitioner is not aware of any disclaimers, reexamination certificates or petitions for inter partes review for the '541 Patent. The '541 Patent is the subject of civil action: *SK nexilis Co., Ltd. v. Solus Advanced Materials Co., Ltd. et al.*, Case 2-23-cv-00539 (EDTX), filed November 21, 2023.

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

Petitioner provides the following designation of counsel.

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D. Service Information

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

Petitioner consents to electronic service by email at IPR57533-0005IP1@fr.com.

Respectfully submitted,

Dated: October 4, 2024

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CERTIFICATION UNDER 37 CFR § 42.24

Under the provisions of 37 CFR § 42.24(d), the undersigned hereby certifies that the word count for the foregoing Petition for *Inter Partes* Review totals 13,861 words, which is less than the 14,000 allowed under 37 CFR § 42.24.

Dated: October 4, 2024

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CERTIFICATE OF SERVICE

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

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