

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Patent of: Kim et al.
U.S. Patent No.: 11,591,706 Attorney Docket No. 57533-0004IP1
Issue Date: February 28, 2023
Appl. Serial No.: 16/959,352
Filing Date: June 30, 2020
Title: ELECTROLYTIC COPPER FOIL HAVING EXCELLENT
HANDLING CHARACTERISTICS IN POSTPROCESSING, AND
MANUFACTURING METHOD THEREFOR

Mail Stop Patent Board

Patent Trial and Appeal Board
U.S. Patent and Trademark Office
P.O. Box 1450
Alexandria, VA 22313-1450

**PETITION FOR *INTER PARTES* REVIEW OF UNITED STATES PATENT
NO. 11,591,706 PURSUANT TO 35 U.S.C. §§ 311–319, 37 C.F.R. § 42**

TABLE OF CONTENTS

I.	INTRODUCTION	1
II.	REQUIREMENTS FOR IPR	1
	A. Grounds for Standing.....	1
	B. Challenge and Relief Requested.....	1
III.	SUMMARY OF THE '706 PATENT	3
	A. Brief Description.....	3
	B. Prosecution History.....	4
	C. Level of Ordinary Skill.....	5
	D. Claim Construction	6
IV.	GROUND 1A: Claims 1-5 are obvious over Kim '761 in view of Cheng and Wolski.....	6
	A. Kim '761	6
	1. Equivalence of R_{pc} and PD.....	7
	B. Cheng	9
	C. Wolski	10
	D. Combination of Kim '761, Cheng, and Wolski.....	11
	1. TC(220)	13
	2. R_z/R_a	15
	3. A POSITA would have had a reasonable expectation of success in optimizing ΔPD , TC(220), and R_z/R_a in combination.....	18
	E. Analysis of Claims.....	19
V.	GROUND 1B: Claims 6 and 8 are obvious over Kim '761, Cheng, Wolski, and Kim '541	32
	A. Kim '541	32
	B. Combination of Kim '761, Cheng, Wolski, and Kim '541 and analysis of [6].....	34
	C. Analysis of [8].....	35
VI.	GROUND 1C: Claim 7 is obvious over Kim '761, Cheng, Wolski, and Lee	39
	A. Lee	39
	B. Combination of Kim '761, Cheng, Wolski, and Lee and analysis of [7]... ..	39
VII.	GROUND 1D: Claims 8-10 are obvious over Kim '761, Cheng, Wolski, Lee, and Shinozaki '681	42

A.	Shinozaki '681	42
B.	Combination of Kim '761, Cheng, Wolski, Lee, and Shinozaki '681 ...	42
C.	Analysis of claims.....	45
VIII.	GROUND 1E: Claim 10 is obvious over Kim '761, Cheng, Wolski, Lee, Shinozaki '681, and Dobashi.....	55
A.	Dobashi	55
B.	Combination of Kim '761, Cheng, Wolski, Shinozaki '681, Lee, and Dobashi and analysis of claim 10	55
IX.	GROUND 2A: Claims 1-5 are obvious over Dobashi, Shinozaki '922, and Chou.....	56
A.	Chou	56
B.	Shinozaki '922	56
C.	Combination of Dobashi, Shinozaki '922, and Chou.....	57
1.	Rz/Ra.....	57
2.	TC(220)	58
3.	Analysis of RSm.....	59
D.	Analysis of claims.....	60
X.	FOUNDATIONS 2B and 2C: Claims 6 and 7 are obvious over Dobashi, Shinozaki '922, Chou, and Lee or Kim '541.....	66
A.	Analysis of claims.....	66
XI.	GROUND 2D: Claims 8-10 are obvious over Dobashi, Shinozaki '922, Chou, Lee, and Shinozaki '681	67
A.	Analysis of claims.....	67
XII.	SECONDARY CONSIDERATIONS	70
XIII.	DISCRETIONARY CONSIDERATIONS	70
A.	§314(a).....	70
B.	35 U.S.C. §325(d).....	71
XIV.	FEES	72
XV.	CONCLUSION.....	72
XVI.	MANDATORY NOTICES UNDER 37 C.F.R § 42.8(a)(1).....	72
A.	Real Party-In-Interest Under 37 C.F.R. § 42.8(b)(1).....	72
B.	Related Matters Under 37 C.F.R. § 42.8(b)(2).....	73
C.	Lead And Back-Up Counsel Under 37 C.F.R. § 42.8(b)(3).....	73
D.	Service Information	73

LIST OF EXHIBITS

SOLUS-1001	U.S. Patent No. 11,591,706 (“the ’706 Patent”)
SOLUS-1002	U.S. Patent No. 11,591,706 File History
SOLUS-1003	Declaration of Dr. Michael Randall
SOLUS-1004	Korean Patent Publication No. 10-2017-0000761
SOLUS-1005	Translation of SOLUS-1004 (“Kim ’761”) and Certificate of Translation
SOLUS-1006	[Reserved]
SOLUS-1007	U.S. Patent No. 9,209,485 (“Cheng”)
SOLUS-1008	U.S. Patent No. 5,834,140 (“Wolski”)
SOLUS-1009	U.S. Patent No. 9,457,541 (“Kim ’541”)
SOLUS-1010	U.S. Patent Application Publication No. 2016/0260981 (“Lee”)
SOLUS-1011	WIPO Publication No. 2014/115681
SOLUS-1012	Translation of SOLUS-1011 (“Shinozaki ’681”) and Certificates of Translation ¹
SOLUS-1013	[Reserved]
SOLUS-1014	U.S. Patent No. 8,715,836 (“Dobashi”)

¹ Title page translated by Michael Fletcher, remainder translated by Dwaine Palmer

SOLUS-1015	U.S. Patent Application Publication No. 2013/0108922 ("Shinozaki '922")
SOLUS-1016	U.S. Patent Application Publication No. 2015/0267313 ("Chou")
SOLUS-1017	ASME B46.1-2009
SOLUS-1018	Excerpts from ASME B46.1-2019
SOLUS-1019	[Reserved]
SOLUS-1020	U.S. Patent No. 10,547,081 ("Kim '081")
SOLUS-1021	JIS B 0601 (1994)
SOLUS-1022	JIS B 0601 (2001)
SOLUS-1023	U.S. Patent No. 9,365,942 ("Tsai")
SOLUS-1024	U.S. Patent No. 7,789,976 ("Sano")
SOLUS-1025	John A. Marshall, "Measuring Copper Surface Roughness for High Speed Applications"
SOLUS-1026	Declaration of June Munford
SOLUS-1027	Korean Publication No. 10-2014-0078883
SOLUS-1028	Translation of SOLUS-1027 ("Lee '883") and Certificate of Translation
SOLUS-1029	[Reserved]
SOLUS-1030	Young, H. (1962). <i>Statistical treatment of experimental data</i> . McGraw-Hill.

SOLUS-1031	U.S. Patent Publication No. 2016/0212846 (“Kohiki”)
SOLUS-1032	Song et al., “Texture and temperature dependence on the mechanical characteristics of copper electrodeposits,” <i>Mat. Sci. and Eng. A</i> , 559 (2013) (“Song”)
SOLUS-1033	U.S. Patent Application Publication No. 2014/0302281 (“Yacovone”)
SOLUS-1034	[Reserved]
SOLUS-1035	Harrington, G.F., Santiso, J. “Back-to-Basics tutorial: X-ray diffraction of thin films,” <i>J Electroceram</i> 47, 141–163 (2021)
SOLUS-1036	ASTM E8/E8M standard
SOLUS-1037	[Reserved]
SOLUS-1038	[Reserved]
SOLUS-1039	<i>Modern Electroplating</i> , 3 rd Ed., Ed. Lowenheim, J. Wiley and Sons, NY, 1974
SOLUS-1040	Rodgers, <i>Professional Manual of Electroplating</i> , University Publishing House, Utah, pp. 115-129
SOLUS-1041	Screen capture of www.textech.co.jp/en/products/foil-electrolytic (September 14, 2024)
SOLUS-1042	Screen capture of www.denora.com/applications/copper-foil-electrodeposition.html (September 14, 2024)
SOLUS-1043	Huang, “Studies of Interfacial Adhesion and Copper Plating Chemistry for Metallization of Through-Package-Vias in Glass Interposers,” Thesis, Georgia Institute of Technology, December 2017

SOLUS-1044	U.S. Patent No. 6,776,893
SOLUS-1045	Vereecken et al., "The chemistry of additives in damascene copper plating," in IBM Journal of Research and Development, vol. 49, no. 1, pp. 3-18, Jan. 2005
SOLUS-1046	<i>SK nexilis Co., Ltd. v. Solus Advanced Materials Co., Ltd. et al.</i> , Case 2-23-cv-00539 (EDTX), Proposed Scheduling Order
SOLUS-1047	<i>SK nexilis Co., Ltd. v. Solus Advanced Materials Co., Ltd. et al.</i> , Case 2-23-cv-00539 (EDTX), Motion to Transfer Venue

LISTING OF CLAIMS

Claim 1	
[1pre]	An electrolytic copper foil having a first surface and a second surface, wherein
[1a]	a texture coefficient of (220) plane of the electrolytic copper foil defined by Equation 1 below is 0.4 to 1.32, $TC(220) = \frac{\frac{I(220)}{I_0(220)}}{\frac{1}{n} \sum \frac{I(hkl)}{I_0(hkl)}}$
[1b]	a difference ($ \Delta(Rz/Ra) $) between Rz/Ra at the first surface of the electrolytic copper foil and Rz/Ra at the second surface of the electrolytic copper foil is less than 2.42, and
[1c]	a difference ($ \Delta PD $) between a peak density (PD) at the first surface of the electrolytic copper foil and a peak density (PD) at the second surface of the electrolytic copper foil is 96 ea or less.
Claim 2	
[2]	The electrolytic copper foil according to claim 1, wherein the second surface is an M surface, and Rz/Ra at the second surface is 4.2 to 9.0
Claim 3	
[3]	The electrolytic copper foil according to claim 2, wherein the first surface is an S surface, and Rz/Ra at the S surface of the electrolytic copper foil is 5.1 to 6.8.

Claim 4	
[4]	The electrolytic copper foil according to claim 1, wherein the electrolytic copper foil has a tensile strength, measured at room temperature, of 30 to 65 kgf/mm ² .
Claim 5	
[5]	The electrolytic copper foil according to claim 1, wherein the electrolytic copper foil has an elongation, measured at room temperature, of 3% or more.
Claim 6	
[6]	The electrolytic copper foil according to claim 1, wherein the electrolytic copper foil has a lateral weight deviation of 5% or less.
Claim 7	
[7]	The electrolytic copper foil according to claim 1, wherein an arithmetic mean of measured heights of corners of four protruding incision portions of the electrolytic copper foil, formed by incising electrolytic copper foil in a form of a cross having a size of 8 cm×8 cm so as to be vertically divided into two parts, is less than 10 mm.
Claim 8	
[8pre]	The electrolytic copper foil of claim 1, wherein the electrolytic copper foil is manufactured by:
[8a]	buffing a surface of a rotary negative electrode drum using a brush having a grit of 500 # to 3000 #;
[8b]	electrodepositing the copper foil on the buffed rotary negative electrode drum by applying electric current between a positive electrode plate and the buffed rotary negative electrode drum, wherein the positive electrode plate and the buffed rotary negative electrode drum are disposed in an electrolytic solution and spaced apart from each other; and
[8c]	winding the electrodeposited copper foil,
[8d]	wherein the electrolytic solution comprises 70 to 90 g/L of copper ions,

[8e]	80 to 120 g/L of sulfuric acid,
[8f]	10 to 20 ppm of chlorine ions,
[8g]	3 to 12 ppm of a sulfide-based compound,
[8h]	25 to 50 ppm of molybdenum (Mo),
[8i]	and 5 to 25 ppm of polyethylene glycol (PEG).
Claim 9	
[9]	The electrolytic copper foil of claim 8, wherein the sulfide-based compound is selected from a group consisting of bis-(sodium sulfopropyl) disulfide (SPS), 3-mercapto 1-propane sulfonate (MPS), and 3-(benzothiazolyl-2-mercapto)-propyl-sulfonate (ZPS).
Claim 10	
[10]	The electrolytic copper foil of claim 8, wherein the sulfide-based compound is SPS.

I. INTRODUCTION

Solus Advanced Materials Co., Ltd. (“Solus” or “Petitioner”) petitions for IPR of claims 1-10 (“Challenged Claims”) of U.S. Patent No. 11,591,706 (“the ’706 Patent”).

II. REQUIREMENTS FOR IPR

A. Grounds for Standing

Solus certifies that the ’706 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. Petitioner is not barred or estopped from requesting this review of the Challenged Claims on the below-identified grounds.

B. Challenge and Relief Requested

Petitioner requests an IPR of the Challenged Claims on the grounds in the table shown below. Additional explanation is provided in the Declaration of Michael Randall. SOLUS-1003, 1-226.

Ground	’706 Patent Claims	Basis
1A	1-5	§ 103 – Kim ’761, Cheng, Wolski
1B	6	§ 103 – Kim ’761, Cheng, Wolski, Kim ’541
1C	7	§ 103 – Kim ’761, Cheng, Wolski, Lee
1D	8-10	§ 103 – Kim ’761, Cheng, Wolski, Lee, Shinozaki ’681
1E	10	§ 103 – Kim ’761, Cheng, Wolski, Lee,

Ground	'706 Patent Claims	Basis
		Shinozaki '681, Dobashi
2A	1-5	§ 103 – Dobashi, Shinozaki '922, Chou
2B	6	§ 103 – Chou, Shinozaki '922, Dobashi, Kim '541
2C	7	§ 103 – Chou, Shinozaki '922, Dobashi, Lee
2D	8-10	§ 103 – Chou, Shinozaki '922, Dobashi, Lee, Shinozaki '681

The '706 Patent claims priority to Korean Application No. 10-2018-0012179, filed January 31, 2018. Although priority entitlement is not conceded, the earliest claimed priority date of the '706 Patent is January 31, 2018. Each reference qualifies as prior art. *See* SOLUS-1026.

Reference	Date ²	Section
Kim '761	1/3/2017 (published)	§ 102(a)(1)
Cheng	12/8/2015 (published) 11/11/2013 (effectively filed)	§ 102(a)(1) § 102(a)(2)
Wolski	11/10/1998 (published) 4/26/1996 (effectively filed)	§ 102(a)(1) § 102(a)(2)
Kim '541	10/4/2016 (published) 7/15/2010 (effectively filed)	§ 102(a)(1) § 102(a)(2)
Lee	9/8/2016 (published) 11/8/2013 (effectively filed)	§ 102(a)(1) § 102(a)(2)

² Petitioner does not concede that the listed dates are the earliest available publication and/or effective filing dates.

Reference	Date ²	Section
Shinozaki '681	7/31/2014 (published) 1/24/2013 (effectively filed)	§ 102(a)(1) § 102(a)(2)
Dobashi	5/6/2014 (published) 10/3/2006 (effectively filed)	§ 102(a)(1) § 102(a)(2)
Chou	9/24/2015 (published) 3/21/2014 (effectively filed)	§ 102(a)(1) § 102(a)(2)
Shinozaki '922	5/2/2013 (published) 6/24/2011 (effectively filed)	§ 102(a)(1) § 102(a)(2)

III. SUMMARY OF THE '706 PATENT

A. Brief Description

The '706 Patent purports to describe “an electrolytic copper foil having excellent handling characteristics in the manufacture of copper foil and in post-processing for manufacturing a secondary battery.” SOLUS-1001, Abstract. As discussed in the '706 Patent's Background, electrolytic copper foils are commonly used as a negative electrode current collector in lithium batteries. *Id.*, 1:31-33. SOLUS-1003, 39.

The '706 Patent purports to provide coppers foils “such that the possibility of the electrolytic copper foil being curled, wrinkled, and/or torn is reduced.” *Id.*, 1:67-2:1. The '706 Patent highlights several features of the copper foils that allegedly provide an improvement. SOLUS-1003, 40.

First, the '706 Patent describes that the “texture coefficient of (220) plane” of the copper foil “is 0.4 to 1.32.” *Id.*, 2:14-16. As Dr. Randall explains, 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, 14-19. The '706 Patent explains that a (220) texture coefficient in this range can provide reduced wrinkles and tearing. SOLUS-1001, 4:9-21; SOLUS-41.

In addition, the '706 Patent describes that a “difference ($|\Delta(Rz/Ra)|$) between Rz/Ra at [a] first surface of the electrolytic copper foil and Rz/Ra at [a] second surface of the electrolytic copper foil is less than 2.42.” *Id.*, 2:24-27. Rz “indicates ten-point average roughness,” Ra “indicates arithmetical average roughness,” and both Rz and Ra are “measured according to JIS B 0601(2001) standards.” *Id.*, 4:26-28, 4:33-35; SOLUS-1003, 42. Dr. Randall has provided an overview of these roughness parameters in view of the cited JIS standard. SOLUS-1003, 20-23.

Further, for the copper foils of the '706 Patent, “it is preferable for the difference between the peak density PD at the first surface of the electrolytic copper foil and the peak density PD at the second surface of the electrolytic copper foil, i.e. $|\Delta PD|$, to be 96 ea or less.” SOLUS-1001, 4:28-32; SOLUS-1003, 43. PD is a roughness parameter measured according to ASME B46.1 standards. *Id.*, 4:34-35. Dr. Randall explains that PD “tells us how many peaks exist per unit length.” SOLUS-1003, 24-27.

B. Prosecution History

The first Office Action during prosecution of the '706 Patent indicated all

claims to recite allowable subject matter. SOLUS-1102, 437. In reference to claim 1 (substantially similar to the issued claim of the '706 Patent), the Examiner stated that

[t]he closest prior art to the instant claims is that of Kim (US 2018/0062199), which teaches a similar foil, (220), and PD as that which is claimed. However, this document was published less than one year from the instant effectively filed date and has common inventors and a common assignee and is therefore excepted under 35 USC 102(a)(2) by 35 USC 102(b)(2)(c). SOLUS-1002, 437.

Although US 2018/0062199 may not be prior art to the '706 Patent, the Examiner appears to have overlooked that Kim '761, an earlier document sharing inventorship and a common assignee with the '706 Patent, provides explicit disclosure of the PD element of claim 1. SOLUS-1003, 46-47.

The application was subsequently allowed after several rounds of minor amendments and a Terminal Disclaimer. As to the reason for allowance, the Notice of Allowance simply referred to the initial non-final Office Action that noted the “(220)” and “PD” elements of claim 1. *Id.*, 26.

C. Level of Ordinary Skill

A person of ordinary skill in the art (“POSITA”) as of the effective filing date of the '706 Patent would have had at least an undergraduate degree in materials science, chemical engineering, electrical engineering, or related field, or

equivalent knowledge, training, or experience, with at least two years of experience working on the development of materials or components for electronic devices such as batteries. Additional education can compensate for less work experience, and vice-versa. SOLUS-1003, 11-12.

D. Claim Construction

Based on the prior art's descriptions of the claimed elements being similar to those of the '706 Patent's specification, no formal claim constructions are necessary in this proceeding because "claim terms need only be construed to the extent necessary to resolve the controversy." *Wellman, Inc. v. Eastman Chem. Co.*, 642 F.3d 1355, 1361 (Fed. Cir. 2011).³

IV. GROUND 1A: Claims 1-5 are obvious over Kim '761 in view of Cheng and Wolski

A. Kim '761

Kim '761 appears to share inventor Seung Min Kim with the '706 Patent and corresponds to U.S. Patent No. 10,480,090, which has been asserted alongside the '706 Patent in co-pending litigation. SOLUS-1003, 48.

Kim '761 relates to "an electrolytic copper foil" having "a first surface and a

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.

second surface opposite to the first surface, wherein each of the first and second surfaces has a peak count roughness R_{pc} of 10 to 100.” SOLUS-1005, Abstract; SOLUS-1003, 49.

Kim ’761 describes that “[a]s a result of repeated research, the present applicant found that a peak count roughness R_{pc} of the electrolytic copper foil 111 is an important factor in stably securing capacity maintenance of 90% or higher.” *Id.*, [0039]. In relation to the preferred R_{pc} range of 10 to 100, Kim ’761 describes that “[w]hen the peak count roughness R_{pc} is less than 10, capacity maintenance of the secondary battery is deteriorated” and that “when the peak count roughness R_{pc} exceeds 100, capacity maintenance of the secondary battery is also deteriorated.” *Id.*, [0043]-[0044]; SOLUS-1003, 50.

Further, Kim ’761 discusses the comparative peak count roughness R_{pc} between the two opposite surfaces 111a and 111b, stating that “[t]he difference in peak count roughness R_{pc} between the shiny surface 111a and the matte surface 111b of the electrolytic copper foil 111 is preferably 60 or less []. When the difference in the peak count roughness R_{pc} exceeds 60, capacity maintenance of the secondary battery is deteriorated due to difference in surface appearance between both surfaces 111a and 111b.” *Id.*, [0045]; SOLUS-1003, 51.

1. Equivalence of R_{pc} and PD

As explained by Dr. Randall, Kim ’761’s peak count roughness R_{pc}

corresponds to the peak density PD of the '706 Patent, to within the level of detail provided by the '706 Patent. SOLUS-1003, 52. He bases this opinion on several factors. First, as Dr. Randall notes, ASME B46.1-2009⁴ provides a definition for “peak density” (referred to in the standard as “Pc” – cf. Kim '761's use of the term “R_{pc}”) that matches the definition in Kim '761. SOLUS-1003, 52; SOLUS-1017, 21.

Second, the criteria lines used by the '706 Patent and Kim '761 are the same ($\pm 0.5 \mu\text{m}$). SOLUS-1003, 53; SOLUS-1001, 8:40; SOLUS-1005, [0014].

Third, the 2019 updated version of the ASME standard uses the abbreviation “R_{pc}” for “peak density,” suggesting that the term “R_{pc}” was in use in the art to refer to the peak density PD discussed in the '706 Patent. SOLUS-1003, 54; SOLUS-1018, 11.

Fourth, the '706 Patent and Kim '761 (which, as noted above, share a common inventor) include very similar descriptions of the measurement of R_{pc} and PD, including the use of the same roughness tester, the same upper/lower criteria levels, and the same sampling/measurement length. SOLUS-1001, 8:36-45; SOLUS-1005, [0064]-[0065]; SOLUS-1003, 55. And both of these passages are

⁴ ASME B46.1-2009 was the version of the cited ASME B46.1 standard in effect as of the effective filing date of the '706 Patent.

themselves very similar to the description of peak density PD provided in Kim '081. SOLUS-1020, 6:56-7:4. The '706 Patent, Kim '761, and Kim '081 share the common inventor Seung Min Kim. Dr. Randall notes that, in his opinion, the similarity of these three passages and the match between their parameters suggests that this inventor used “peak density PD” and “peak count roughness R_{pc} ” interchangeably to indicate the same parameter, measured using the same measurement parameters. SOLUS-1003, 55. Dr. Randall also describes how the '706 Patent's PD and Kim '761's R_{pc} can be compared directly to one another based on their common units. SOLUS-1003, 56-57.

B. Cheng

Cheng relates to “[a]n electrolytic copper foil [having] a shiny side and a matte side with a roughness of less than 2 μm .” SOLUS-1007, Abstract. Cheng notes that “the (220) surface and (311) surface of the electrolytic copper foil of the present invention have promising crystalline phase characteristics, such that the elongation of the electrolytic copper foil can be greater than 14%. It is further discovered that the electrolytic copper foil with these crystalline phase characteristics resolves the problem of not [being] suitable for use in a lithium ion secondary battery caused by the high roughness of traditional products.” SOLUS-1007, 3:16-23. Among other description, Cheng discloses TC(220), Rz (ten-point roughness), tensile strength, and elongation for copper foils manufactured

according to various process parameters. SOLUS-1007, Table 3; SOLUS-1003, 58.

As Dr. Randall discusses, Cheng's texture coefficients (TC) correspond to the TC of the '706 Patent, to within the level of detail provided by the '706 Patent. SOLUS-1003, 59. Notably, the TC calculation formulas provided in each document are the same, and the same four crystal planes ((111), (200), (220), and (311)) are considered in TC calculation in each document. SOLUS-1001, 3:55, 4:1-8; SOLUS-1007, 2:52-54, 7:25; SOLUS-1003, 59.

C. Wolski

Wolski relates to "an electrodeposited copper foil" in which "the surface roughness R_z of the matte side of the untreated copper foil is the same as or less than the surface roughness R_z of the shiny side of this untreated copper foil." SOLUS-1008, Abstract; SOLUS-1003, 60-61. Wolski describes the electrodeposition conditions of "untreated copper foils" and provides R_z and R_a values for each of the matte side and the shiny side of the copper foils. *Id.*, 6:51-9:21, Table 2.

Wolski describes that "the surface roughness R_z at the matte side of the untreated copper foil of the present invention is the same or smaller than the surface roughness R_z at the shiny side of said untreated copper foil so that the surface treated copper foil after subjecting to bond enhancing treatment onto the matte side becomes more low-profiled one as compared with the conventional

foil.” *Id.*, 6:36-42.

As Dr. Randall discusses, the R_z and R_a disclosed by Wolski correspond to the R_z and R_a described and claimed by the '706 Patent, to within the level of detail provided by the '706 Patent. SOLUS-1003, 62. The '706 Patent describes that “ R_z indicates ten-point average roughness, and R_a indicates arithmetical average roughness” and that “ R_z and R_a may be measured according to JIS B 0601(2001) standards.” SOLUS-1001, 4:26-34. Similarly, Wolski describes that “the surface roughnesses R_z and R_a are R_z and R_a defined in [] JIS B 0601-1994. That is, R_z is a ten-point mean roughness [] and R_a is a center-line mean roughness.” SOLUS-1008, 7:10-22. Dr. Randall notes that the 1994 and 2001 versions of the cited standard provide equivalent formulas/descriptions for calculation of each of R_z and R_a , with the proviso that the 2001 version renames the ten-point average roughness to R_{zJIS} . SOLUS-1003, 62; SOLUS-1021, 13-15; SOLUS-1022, 24-25.

D. Combination of Kim '761, Cheng, and Wolski

It would have been obvious to a POSITA to apply the teachings of Cheng and Wolski to the copper foil of Kim '761 in order to, among other things, obtain modified copper foils having (i) the peak count roughnesses R_{pc} (and, correspondingly, $|\Delta PD|$) of Kim '761, (ii) the R_z/R_a ratios of Wolski, and (iii) the TC(220) of Cheng. SOLUS-1003, 63.

First, although this copper foil is referred to herein as a “modified” copper foil, it is not conceded that any modifications to Kim ’761 would actually be necessary in order to obtain the copper foils recited in claims 1-5. Kim ’761 provides R_{zJIS} (ten-point roughness, corresponding to R_z in the ’706 Patent) values for its two surfaces but does not explicitly mention R_a for those surfaces, and also does not mention specific TC. Meanwhile, Cheng discloses TC but does not explicitly mention PD or R_z/R_a for both surfaces, and Wolski provides full disclosure of R_z/R_a for both surface but lacks a detailed description of TC and PD. SOLUS-1003, 64.

As such, the combination of Kim ’761, Cheng, and Wolski (“Kim’761-Cheng-Wolski”) discussed with respect to claims 1-5 should not be taken to indicate any substantive difference between Kim ’761’s copper foil and that of claims 1-5. Rather, the combination accounts for claim 1’s recitation of three specific material properties that do not appear to have been measured (or were simply not mentioned) together in any single identified reference. SOLUS-1003, 65. We are advised of “the 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.

The foregoing notwithstanding, the prior art provides ample motivation and guidance for modifying Kim '761's copper foil to obtain the TC(220) and Rz/Ra values disclosed by Cheng and Wolski. SOLUS-1003, 66.

1. TC(220)

It would have been obvious to modify Kim '761's copper foil to obtain the TC(220) values disclosed by Cheng. SOLUS-1003, 67. Cheng recognizes that TC(220) is correlated with crystalline grain size and roughness, noting that "when [] the texture coefficients of a (220) surface and a (311) surface of an electrolytic copper foil are higher, the crystalline grains of the electrolytic copper foil become larger and the roughness of the M side become higher." SOLUS-1007, 2:30-35. For example, Cheng notes that certain TC(220) values (in combination with TC(311) values) are associated with "significantly increased" elongation and a low matte-side roughness. *Id.*, 4:18-28. Foils having the crystalline phase structure associated with the disclosed TC(220) values (in combination with TC(311) values) also have a "roughness difference between both sides" that is "extremely small [such that] it was thus not easy for the electrolytic copper foil to break or fracture." *Id.*, 10:27-34. A POSITA would have been motivated to optimize texture coefficients such as TC(220) at least in order to obtain the foregoing benefits. SOLUS-1003, 67.

As such, Cheng provides a clear recognition of texture coefficients including

TC(220) as result-effective variables, such that it would have been obvious to a POSITA to optimize TC(220) by, for example, fabricating a copper foil having the texture coefficients – including TC(220) values – that Cheng describes as providing effective results. SOLUS-1003, 68. *See, e.g., In re Antonie*, 559 F.2d 618 (C.C.P.A. 1977) (finding that “the discovery of an optimum value of a variable in a known process is normally obvious” when “the parameter optimized was [] recognized to be a result-effective variable”); *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”); *In re Applied Materials, Inc.*, 692 F.3d 1289, 1297 (Fed. Cir. 2012) (“A recognition in the prior art that a property is affected by the variable is sufficient to find the variable result-effective.”)

Moreover, a POSITA would have had a reasonable expectation of success in obtaining the TC(220) values described by Cheng. SOLUS-1003, 69. For example, Cheng describes process parameters such as electrolytic solution composition, temperature, and electrolysis current associated with manufacture of the disclosed foils. SOLUS-1007, 4:40-59, 4:66-5:2, 5:11-18, Table 1. Cheng also notes that the disclosed foils were “thus-obtained” by “the addition of acid-denatured polyvinyl alcohol [] to the copper sulfate electrolyte.” SOLUS-1007, 4:4-11. Further, as Dr. Randall discusses, “the electrodeposition process described by Cheng represents no

great departure from that described in Kim '761. The two references describe deposition at similar temperatures, using similar plating currents, in solutions composed primarily of similar amounts of copper ions and sulfuric acid. It would have been obvious to try slightly modifying Kim '761's solution by, for example, including the polyvinyl alcohol and/or small molecular weight glue incorporated into Cheng's solution, to obtain Cheng's TC(220) values." SOLUS-1003, 70.

2. Rz/Ra

It would also have been obvious to modify Kim '761's copper foil to obtain the Rz and Ra values (and, accordingly, the Rz/Ra values) disclosed by Wolski. SOLUS-1003, 71. Wolski describes the desirability of having "both surfaces of the untreated copper foil" be "flat." SOLUS-1008, 9:27-28, 12:22-23. Considering the two surfaces together, Wolski describes the desirability of having "the surface roughness R_z at the matte side of the untreated copper foil [be] the same or smaller than the surface roughness R_z at the shiny side of said untreated copper foil so that the surface treated copper foil after subjecting to bond enhancing treatment onto the matte side becomes more low-profiled one as compared with the conventional foil." *Id.*, 6:36-42. The copper foils having the disclosed R_z and R_a values also exhibit "excellent" "elongation characteristics" and "high tensile strength" and are, based on their surface roughness, particularly compatible with a subsequent bond enhancing treatment. *Id.*, 9:28-29, 11:37-12:5, 12:16. A POSITA would thus have

been motivated to optimize R_z and R_a at least in order to obtain the foregoing benefits. SOLUS-1003, 71.

As Dr. Randall discusses, this disclosure by Wolski comports with a broad recognition in the art that similar surface profiles (e.g., roughness) between the matte side and the shiny side were desirable. SOLUS-1003, 72. For example, Cheng discusses that a “small” “roughness difference between both sides” results in decreased breaking and fracturing during charging-discharging cycles, thus increasing battery life. SOLUS-1007, 10:30-34. Tsai teaches the desirability of “low roughness at both sides and extremely small difference in roughness between both sides.” SOLUS-1023, 3:14-15. Dr. Randall provides other examples of this understanding, as well.

Accordingly, roughness parameters such as R_z and R_a were well-established as result-effective, such that it would have been obvious to a POSITA to optimize R_z and R_a by, for example, fabricating a copper foil having the R_z and R_a values, on both matte and shiny sides, disclosed by Wolski and known to provide good results. SOLUS-1003, 73. For example, based at least on the foregoing art disclosures that target similar roughness between the two sides, it would have been obvious to produce a copper foil having similar surface properties between matte and shiny sides, e.g., a low difference in R_z/R_a ratio ($|\Delta(R_z/R_a)|$) between the two sides. SOLUS-1003, 73. In arriving at the R_z and R_a values disclosed by Wolski, a

POSITA would have also arrived at the Rz/Ra ratios disclosed by Wolski. *Id.*

It would additionally have been obvious to a POSITA to optimize Rz/Ra and arrive at these Rz/Ra ratios based on the recognition in the art that, for copper foil, “higher Rz : Ra [i.e., Rz/Ra] indicat[es] increased non-uniformity,” such that a POSITA seeking to obtain a uniform surface would try to obtain a small Rz/Ra ratio, and a POSITA seeking similarly-uniform matte and shiny surfaces would try to obtain a small $|\Delta(\text{Rz/Ra})|$. SOLUS-1025, 2; SOLUS-1003, 74.

A POSITA would have had a reasonable expectation of success in obtaining these Rz and Ra values. SOLUS-1003, 75. Wolski provides detailed description regarding parameters such as electrolytic solution composition, temperature, and electrolysis current associated with manufacture of the disclosed foils. SOLUS-1008, 652-7:3, Table 1. Wolski specifically notes the efficacy of including “3-mercapto 1-propanesulfonate” (MPS) in combination with a “low molecular weight glue” and a small amount of chlorine ions in order to obtain the disclosed roughness values. *Id.*, 4:66-6:35. Dr. Randall notes that “with respect to those specifically-noted solution components, Kim ’761 already discloses the inclusion of chlorine ions, and Cheng already discloses the inclusion of MPS and low molecular weight glue. [] Also, the electrodeposition temperature, current density, and primary solution components (copper ions, sulfuric acid) and proportions are the same or similar between Kim ’671, Cheng, and Wolski. [] It would have been

obvious to try slightly modifying Kim '761's solution by, for example, including the MPS, low molecular weight glue, and chlorine ions in the proportions disclosed by Wolski, to obtain Wolski's R_z and R_a values." SOLUS-1003, 75.

See also Section V.C for an explanation of why a POSITA would have had a reasonable expectation of success in obtaining target R_z and R_a values for the shiny side. SOLUS-1003, 27-29, 76.

3. A POSITA would have had a reasonable expectation of success in optimizing ΔPD , TC(220), and R_z/R_a in combination

As discussed above in Sections IV.D.1-2, a POSITA would have had a reasonable expectation of success in obtaining the ΔPD , TC(220), and R_z/R_a values disclosed by Kim '761, Cheng, and Wolski, respectively. To the extent the Patent Owner may argue that **simultaneous** optimization of these variables would have been beyond the skill of a POSITA, Dr. Randall explains that this assertion is unsupported. SOLUS-1003, 77-78. He points out that "[a]ccording to the '706 Patent, the claimed ΔPD values result from a particular PEG concentration range in the electrolytic solution. [] The claimed $|\Delta(R_z/R_a)|$ values result from a particular Mo concentration range in the solution. [] The claimed TC(220) values result from a particular sulfide-based compound composition range in the electrolytic solution. That is, the '706 Patent teaches that the three claimed ranges can be achieved by optimizing three independent process parameters **separately**, without requiring

special consideration or care to achieve the values jointly. [] For the foregoing reasons, the joint optimization of these three parameters would have been well within the skill of a POSITA.” SOLUS-1003, 78.

It is inappropriate to hold the prior art to a stricter standard of disclosure than what is disclosed in the specification of the patent itself. *See In re Epstein*, 32 F.3d 1559, 1568 (Fed. Cir. 1994). Given that the ’706 Patent itself recognizes that these three process parameters can be separately and independently tuned to obtain the claimed ranges of ΔPD , TC(220), and $|\Delta(Rz/Ra)|$, which is something that a POSITA would have recognized, it would be inappropriate to require that the prior art explicitly disclose or consider the joint optimization of all three.

E. Analysis of Claims

[Ipre]:

To the extent the preamble is limiting, the Kim’761-Cheng-Wolski copper foil discussed in Section IV.D satisfies or renders obvious an electrolytic copper foil having a first surface and a second surface.⁵ SOLUS-1003, 79. For example, Kim ’761 discloses that “[t]he electrolytic copper foil [] of the present invention may be formed on a rotational [] drum by electroplating, thereby having a first surface [] which contacts the rotational [] drum in the process of electroplating, and

⁵ Petitioner does not concede that this preamble is limiting.

a second surface [] opposite to the first surface.” SOLUS-1005, [0030].

[1a]:

The Kim’761-Cheng-Wolski foil, which adopts TC(220) values such as those disclosed by Cheng, satisfies or renders obvious a TC(220) of 0.4 to 1.32. SOLUS-1003, 80. For example, as shown in Cheng Table 3 (reproduced below), TC(220) for each of Cheng’s six embodiments has a value within the claimed range. Further, of Cheng’s six “comparative examples” (control samples fabricated without the use of polyvinyl alcohol), five have TC(220) within the claimed range. SOLUS-1007, 5:51-6:43. This latter finding suggests to Dr. Randall that the manufacture of copper foils having the claimed TC(220) is robust to various process conditions and reinforces his opinion that such manufacture would have been well within the skill of a POSITA. SOLUS-1003, 80.

TABLE 3-continued

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

TABLE 4

Test results of the characteristics of electrolytic copper foil			
	Embodiment 5	Embodiment 6	Comparative Example 6
Tensile strength (kg/mm^2)	33.7	33.5	34.5
Elongation (%)	9.4	9.7	6.2
Roughness of S side, Rz (μm)	1.85	1.77	1.74
Roughness of M side, Rz (μm)	1.55	1.54	1.58
Roughness (Rz) difference between S side and M side (μm)	0.30	0.23	0.16
Weight resistivity ($\Omega\text{g}/\text{m}^2$)	0.157	0.156	0.163
TC(111)	0.84	0.71	1.04
TC(200)	0.71	0.66	1.87
TC(220)	1.09	1.09	0.80
TC(311)	1.36	1.54	0.29
TC(220) + TC(311)/TC(total) %	61	66	27
Crack on copper foil after charging-discharging test	No	No	Yes

Annotated Cheng Tables 3-4

The disclosure of the foregoing values within the claimed range renders obvious the claimed range. “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).

[1b]:

The Kim’761-Cheng-Wolski foil, which adopts Rz and Ra values such as those disclosed by Wolski, satisfies or renders obvious a $|\Delta(Rz/Ra)|$ of less than 2.42. SOLUS-1003, 81. As shown in Wolski’s Table 2 below (which has been truncated and augmented to include a column for $|\Delta(Rz/Ra)|$), the foils of each of Wolski’s Examples 1-4 have $|\Delta(Rz/Ra)|$ well within the claimed range, despite the different electrolytic solution compositions used to produce these foils. SOLUS-1008, Table 1. Dr. Randall notes that this suggests a high degree of robustness for achieving the claimed $|\Delta(Rz/Ra)|$. SOLUS-1003, 81.

	Matte side		Shiny side		
	roughness (μm)		roughness (μm)		
	R_z	R_a	R_z	R_a	$ \Delta(R_z/R_a) $
Example 1	1.3	0.30	2.0	0.40	0.67
Example 2	2.1	0.32	2.1	0.35	0.56
Example 3	1.1	0.20	1.8	0.35	0.36
Example 4	0.6	0.14	1.4	0.23	1.8
Comparative example 1	3.3	0.40	2.0	0.37	2.8
Comparative example 2	4.8	0.70	2.1	0.32	0.29

Modified Wolski Table 2

[1c]:

The Kim '761-Cheng-Wolski foil, having the R_{pc} values disclosed by Kim '761, satisfies or renders obvious a $|\Delta PD|$ of 96 ea or less. SOLUS-1003, 82-84. As discussed in Section IV.A.1, Kim '761's R_{pc} can be compared directly to the '706 Patent's PD. As such, Kim '761's disclosure that "each of the first and second surfaces has a peak count roughness R_{pc} of 10 to 100" directly discloses the claimed $|\Delta PD|$ range, because the largest $|\Delta PD|$ attainable under Kim '761's description is $|\Delta PD| = 90$ ea, corresponding to one surface with $PD = 100$ and another surface with $PD = 10$. SOLUS-1005, Abstract; SOLUS-1003, 82. That is, Kim '761's disclosed $|\Delta PD|$ range is **narrower** than the claimed range, rendering

the claimed range obvious.

Additional disclosure of the claimed $|\Delta PD|$ range is found in Kim '761's Table 1, which provides specific "Difference in R_{pc} " values (corresponding to $|\Delta PD|$ within the level of detail provided by the '706 Patent) for each of four example devices and four comparative examples (control samples), where the comparative examples were processed under different conditions than the four example devices. SOLUS-1005, [0063], Table 1; SOLUS-1003, 83. As shown in the annotated table below, $|\Delta PD|$ for each of the four examples, and for three of the four comparative examples, lie within the claimed range. "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* at 782.

<i>Table 1</i>						
	Heat treatment temperature of copper wire (°C)	Whether continuous filtration is conducted	Grit of polishing brush (#)	R _{pc} of matte surface (count)	R _{pc} of shiny surface (count)	Difference in R _{pc} (count)
Ex. 1	720	○	1200	13	42	29
Ex. 2	700	○	1400	20	24	4
Ex. 3	680	○	800	39	98	59
Ex. 4	660	○	1000	98	89	9
Comp. Ex. 1	810	○	1600	8	9	1
Comp. Ex. 2	-	○	700	112	128	16
Comp. Ex. 3	-	×	1200	181	47	134
Comp. Ex. 4	670	○	600	47	139	92

Annotated Kim '761 Table 1

[2]:

The Kim'761-Cheng-Wolski foil, adopting Rz and Ra values such as those disclosed by Wolski, satisfies or renders obvious that the second surface is an M surface and has Rz/Ra of 4.2 to 9.0. SOLUS-1003, 85. According to the '706 Patent, "M surface" refers to the "matte surface." SOLUS-1001, 3:37-38. As shown in the modified Wolski Table 2 below, the matte side of each of Wolski's examples and comparative examples has Rz/Ra within the claimed range, rendering obvious the claimed range. According to Dr. Randall, the fact that all of Wolski's foils fall within the claimed range, despite their different electrolytic solution compositions, suggests that a POSITA would have had a reasonable expectation of success in fabricating the Kim'761-Cheng-Wolski copper foil

having the matte-side Rz, Ra, and Rz/Ra disclosed by Wolski. SOLUS-1003, 85.

	Matte side		Shiny side		M surface Rz/Ra
	roughness (μm)		roughness (μm)		
	R _z	R _a	R _z	R _a	
Example 1	1.3	0.30	2.0	0.40	4.3
Example 2	2.1	0.32	2.1	0.35	6.6
Example 3	1.1	0.20	1.8	0.35	5.5
Example 4	0.6	0.14	1.4	0.23	4.3
Compar- ative example 1	3.3	0.40	2.0	0.37	8.3
Compar- ative example 2	4.8	0.70	2.1	0.32	6.9

Modified Wolski Table 2

[3]:

The Kim'761-Cheng-Wolski foil, adopting Rz and Ra values such as those disclosed by Wolski, satisfies or renders obvious that the first surface is an S surface and has Rz/Ra of 5.1 to 6.8. SOLUS-1003, 86. According to the '706 Patent, "S surface" refers to the "shiny surface." SOLUS-1001, 3:34. As shown in the modified Wolski Table 2 below, the shiny side of each of Wolski's examples 2-4 and comparative examples 1 and 2 has Rz/Ra within the claimed range, rendering obvious the claimed range. The sole example of Wolski exhibiting a shiny surface Rz/Ra outside the claimed range has Rz/Ra = 5.0, within 2% of the

claimed range. As Dr. Randall discusses, shiny surface roughness characteristics are primarily a function of the surface characteristics of the drum on which the shiny surface is grown, such that a POSITA would have had a reasonable expectation of success in fabricating the Kim'761-Cheng-Wolski copper foil having the shiny-side Rz, Ra, and Rz/Ra disclosed by Wolski. SOLUS-1003, 27-29, 86.

	Matte side		Shiny side		S surface Rz/Ra
	roughness (μm)		roughness (μm)		
	R _z	R _a	R _z	R _a	
Example 1	1.3	0.30	2.0	0.40	5.0
Example 2	2.1	0.32	2.1	0.35	6.0
Example 3	1.1	0.20	1.8	0.35	5.1
Example 4	0.6	0.14	1.4	0.23	6.1
Comparative example 1	3.3	0.40	2.0	0.37	5.4
Comparative example 2	4.8	0.70	2.1	0.32	6.6

Modified Wolski Table 2

[4]:

Kim'761-Cheng-Wolski renders obvious a room-temperature tensile strength of 30 to 65 kgf/mm². SOLUS-1003, 87. Each of these references discloses

tensile strengths. SOLUS-1005, [0029]; SOLUS-1007, 6:56-63, Tables 3-4; SOLUS-1008, Table 2. Cheng and Wolski describe that their measurements are conducted at room temperature. SOLUS-1007, 6:56-63; SOLUS-1008, Table 2. Kim '761 does not provide a measurement temperature, but Dr. Randall explains that, in the absence of a disclosed measurement temperature, a POSITA would have understood the measurement to have been conducted at room temperature. SOLUS-1003, 88-89.

The disclosed values, or ranges thereof, are shown in the table below. Kim '761 provides a range entirely within the claimed range; Cheng provides six examples of values, each of which is within the claimed range; and Wolski provides four examples of values, each of which is within the claimed range. SOLUS-1005, [0029]; SOLUS-1007, 6:56-63, Tables 3-4; SOLUS-1008, Table 2; SOLUS-1003, 90-91, 96.

Claimed tensile strength (kgf/mm²)	Kim '761 tensile strength (kgf/mm²)	Cheng tensile strength (kg/mm²)	Wolski tensile strength (kgf/mm²)
30 - 65	30 - 60	31.3 – 33.7	33.6 – 37.2

Dr. Randall discusses that “the modified foil – resulting from a combination of Kim '761, Cheng, and Wolski – would be expected to have tensile strength

similar to those of Kim '761, Cheng, and Wolski.” SOLUS-1003, 92. Based on the disclosed values above, this tensile strength would be within the claimed range, rendering obvious the range.

Alternatively, claim 4 is obvious because it would have been obvious to optimize the foil to arrive at a tensile strength within the claimed range. SOLUS-1003, 93. By measuring and disclosing tensile strength, each of Kim '761, Cheng, and Wolski recognizes the importance of this parameter. *Id.* Further, Wolski explicitly describes the importance of “high tensile strength” for “dimensional stability.” SOLUS-1008, 2:34-35. Accordingly, a POSITA would have been highly motivated to obtain an optimized tensile strength such as one within the claimed range. SOLUS-1003, 93.

“[W]here 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.” *In re Aller* at 456. Here, there can be no doubt that the “general conditions of the claim” are disclosed in the prior art: each of the three cited references discloses a tensile strength satisfying the claim. Further, Dr. Randall notes that a POSITA would have had a reasonable expectation of success in achieving the optimized tensile strength, “(1) because the prior art provides detailed process parameters that provide tensile strengths in the claimed range, (2) because the prior art achieves tensile strengths in the claimed range using a variety

of different process parameters (corresponding to different examples), suggesting that these tensile strengths can be achieved robustly/insensitively and predictably, and (3) because Cheng describes specifically that TC(111) and TC(200) can be tuned to achieve a higher tensile strength.” SOLUS-1003, 94-95. Accordingly, obtaining a room-temperature tensile strength in the claimed range would have been well within the skill of a POSITA to achieve by routine experimentation. *Id.*

For at least the foregoing reasons, the claimed room-temperature tensile strengths are obvious.

[5]:

Kim’761-Cheng-Wolski renders obvious a room-temperature elongation of 3% or more. SOLUS-1003, 97-98. The rationale here is generally similar to that provided for [4] above. Both Cheng and Wolski describe various room-temperature elongation values, all of which satisfy the claimed range, as shown in the below table. SOLUS-1007, 6:64-7:4, Tables 3-4; SOLUS-1008, Table 2.

Claimed Elongation	Cheng Elongation	Wolski Elongation
3% or more	9.4 – 15.6 %	11.7 – 19.8 %

Dr. Randall notes that “given the disclosure in [various prior art cited herein], an elongation of ‘3% or more’ does not appear to be at all remarkable or to

constitute an improvement to the prior art.” SOLUS-1003, 99.

Also, “given that the modified foil results from a combination of Kim ’761, Cheng, and Wolski, the foil would be expected to have an elongation similar to those of Cheng and Wolski.” SOLUS-1003, 100. This expectation is strengthened by the fact that “the electrolytic solutions and other process parameters used by Kim ’761, Cheng, and Wolski are similar to one another” and by the recognition that “the disclosed elongations of Cheng and Wolski are well beyond the claimed range minimum value of 3%, such that, even if the modified foil had a significantly lower elongation – for example, 50% lower – the modified foil would still satisfy claim 5.” SOLUS-1003, 100. Based on this reasoning, the Kim’761-Cheng-Wolski foil renders obvious the claimed range by having a room-temperature elongation within the claimed range.

Alternatively, claim 5 is obvious because it would have been obvious to optimize the foil to arrive at an elongation within the claimed range. SOLUS-1003, 101. Both Cheng and Wolski describe the desirability of a high elongation. SOLUS-1007, 3:13-19, 4:20-23; SOLUS-1008, 2:36-59, 5:55-65. Accordingly, a POSITA would have been highly motivated to obtain a high elongation, such as one within the claimed range. SOLUS-1003, 101.

For reasons similar to those discussed above with respect to [4], because “the general conditions of” claim 5 “are disclosed in the prior art, it is not inventive

to discover the optimum or workable ranges by routine experimentation.” *In re Aller* at 456. Here, both Cheng and Wolski disclose high elongations that easily satisfy the claimed range, such that the general conditions of the claim are satisfied by the prior art. And, as discussed above for [4], because of the art’s detailed process disclosures, apparent robustness and predictability of obtaining high room-temperature elongation, and disclosure of particular process parameters associated with high elongation, a POSITA would have had a reasonable expectation of success in achieving the claimed elongations by routine experimentation. SOLUS-1003, 102-103.

V. GROUND 1B: Claims 6 and 8 are obvious over Kim ’761, Cheng, Wolski, and Kim ’541

A. Kim ’541

Kim ’541 relates to a “copper foil for a current collector of a lithium secondary battery” having particular texture coefficients, surface roughness, weight deviation, tensile strength, elongation, and thickness. SOLUS-1009, Abstract. Inventor Dae-Young Kim is shared between Kim ’541 and Kim ’761. SOLUS-1003, 104.

Kim ’541 describes that, when parameters including “weight deviation” are optimized, “the generation of wrinkles at a surface of the copper foil” can be “effectively decrease[d].” SOLUS-1009, 2:5-10. Specifically, Kim ’541 discloses

that “[t]he weight deviation of the copper foil should be 3% or less. If the weight deviation exceeds 3%, property deviations occur at the surface of the copper foil, which may increase the number of wrinkles and make properties of the current collector irregular.” *Id.*, 4:26-30. SOLUS-1003, 105.

Kim ’541 provides process parameters that can be used to fabricate copper foils having low weight deviation. SOLUS-1009, 3:8-22; SOLUS-1003, 106.

Using these process parameters, Kim ’541 fabricates seven different copper foils, the weight deviations of which range from 0.4% to 2.6%:

	Examples						
	1	2	3	4	5	6	7
(220) ratio [%]	24	38	17	30	29	19	34
Tensile strength [kg/mm ²]	32.2	33.7	34.5	32.6	32.1	37.2	33.1
Weight deviation [%]	0.4	0.7	0.8	1.6	0.4	2.6	1.2
Number of wrinkles [ea]	0	0	0	0	0	0	0

Modified Table 1 of Kim ’541

Dr. Randall discusses that the “weight deviation” of Kim ’541 corresponds to the “lateral weight deviation” of the ’706 Patent, to within the level of detail provided by the ’706 Patent. SOLUS-1003, 108-109. For example, Dr. Randall compares the descriptions provided with respect to these parameters in the two

patents to determine that they correspond to one another, to within the level of detail provided by the '706 Patent. *Id.*

B. Combination of Kim '761, Cheng, Wolski, and Kim '541 and analysis of [6].

[6]:

The combination of Kim '761, Cheng, Wolski, and Kim '541 renders obvious the claimed lateral weight deviation. As discussed in Section V.A, Kim '541 establishes the importance of weight deviation and describes the desirability of having a low weight deviation, e.g., “3% or less” in order to avoid “property deviations [] which may increase the number of wrinkles.” SOLUS-1009,4:26-29. SOLUS-1003, 110.

Based on this disclosure, it would have been obvious and within the skill of a POSITA to optimize the manufacture of the foil of Kim '761, Cheng, and Wolski in order to obtain a weight deviation of 3% or less, necessarily satisfying claim 6's recitation of a lateral weight deviation of 5% or less. SOLUS-1003, 111. Dr. Randall describes why a POSITA would have had a reasonable expectation of success in obtaining the low weight deviation. *Id.*

For example, Kim '541 discloses that low weight deviations can be obtained by using an electrolytic solution including “copper sulfate, sulfuric acid, [] chlorine,” and “a small amount of organic additives” such as “a sulfonate based

additive containing sulfide,” “gelatin having a low molecular weight [], or a cellulose based additive.” SOLUS-1009, 3:8-17. This clear guidance renders the low weight deviations obvious. “When there is a design need or market pressure to solve a problem and there are a finite number of identified, predictable solutions, a person of ordinary skill in the art has good reason to pursue the known options within his or her technical grasp.” *KSR* at 402.

Dr. Randall also discusses that the electrolytic solutions and process parameters of Kim ’761, Cheng, and Wolski match or are similar to those described by Kim ’541 in association with the low weight deviation, such that a POSITA would have had a reasonable expectation of success in obtaining the low lateral weight deviation. SOLUS-1003, 111.

As a result, it would have been obvious to obtain the modified foil discussed in Section IV.D with a lateral weight deviation of 5% or less, e.g., using the combined fabrication process of Kim ’761, Cheng, Wolski, and Kim ’541. SOLUS-103, 112.

C. Analysis of [8]

The preamble of claim 8 recites “[t]he electrolytic copper foil of claim 1, wherein the electrolytic copper foil is manufactured by:”. This preamble establishes claim 8 as a product-by-process claim. “If the product in a product-by-process claim is the same as or obvious from a product of the prior art, the claim is

unpatentable even though the prior product was made by a different process.” *In re Thorpe*, 777 F.2d 695, 697 (Fed. Cir. 1985). Here, the ’706 Patent describes that several parameters of the process claimed in claim 8 result in an improved product. However, as shown below, each of these improvements to the product is obvious over the combination of Kim ’761, Cheng, Wolski, and Kim ’541, such that claim 8 is also obvious, even without an analysis of the obviousness of the recited process steps. SOLUS-1003, 113-114. “[The] patentability of a claim to a *product* does not rest merely on a difference in the method by which that product is made. Rather, it is the product itself which must be new and unobvious [emphasis in original].” *In re Pilkington*, 411 F.2d 1345, 1348 (C.C.P.A. 1969).

Claimed process step	Described product characteristics	Obviousness of product characteristics
buffing...	1. “the range of Rz/Ra of the S surface of the electrodeposited electrolytic copper foil is 5.1 to 6.8” SOLUS-1001, 6:31-39 2. “the peak density of the S surface [] is a relatively uniform value of 10 to 20 ea.” SOLUS-1001, 40-45	1. See [3] above 2. [see below]
electrodepositing the copper foil...; and	Results in manufacture of the foil	Obvious in view of disclosure of electrodeposited copper foils.

		SOLUS-1003, 114.
winding...,	[no disclosed product characteristics]	
70 to 90 g/L of copper ions,	[no disclosed product characteristics]	
80 to 120 g/L of sulfuric acid,	[no disclosed product characteristics]	
10 to 20 ppm of chlorine ions,	[no disclosed product characteristics]	
3 to 12 ppm of a sulfide-based compound,	TC(220) in range from 0.4 to 1.32. SOLUS-1001, 4:9-21, 6:5-20.	See [1a] above
25 to 50 ppm of molybdenum (Mo),	1. $ \Delta(R_z/R_a) $ less than 242. SOLUS-1001, 4:22-26; 6:55-57. 2. If Mo below this range, “locally nonuniform plating” and “M surface of the copper foil is stained or nonuniformly electroplated.” SOLUS-1001, 6:59-63.	1. See [1b] above 2. See [6] above (low weight deviation corresponds to uniformly-deposited foils). SOLUS-1003, 115. Art discloses no “staining” <i>Id.</i>
5 to 25 ppm of polyethylene glycol (PEG).	1. Small difference in the PD values between the M surface and the S surface. SOLUS-1001, 7:11-13.	1. See [1c] above 2. See [2] above

	2. Rz/Ra at M surface is at least 4.2. SOLUS-1001, 7:13-17.	
--	---	--

With reference to the '706 Patent's disclosure that "the peak density of the S surface [] is a relatively uniform value of 10 to 20 ea" in association with the process element of "buffing," this product characteristic is obvious. Kim '761 discloses that R_{pc} (PD) for the shiny side is in a range of 10 to 100, overlapping and encompassing the range associated with the recited Mo concentration and thereby rendering obvious that range. SOLUS-1005, [0042]. Dr. Randall also explains that it would have been obvious to try peak densities within the range of 10 to 20 ea, which would have been attainable with a high expectation of success. SOLUS-1003, 116-117. He bases this finding on his analysis that, according to various art documents, roughness characteristics of the shiny side can be tuned with a high degree of predictability, and that a POSITA would have been motivated to optimize the shiny side PD of Kim '761 based on Kim '761's focus on PD as a parameter of interest. *Id.*, 117-118.

For the foregoing reasons, the product produced by the process of claim 8 is obvious. It follows that claim 8 is also obvious. *Id.*, 119.

VI. GROUND 1C: Claim 7 is obvious over Kim '761, Cheng, Wolski, and Lee

A. Lee

Lee relates to “an electrodeposited copper foil” that has “low roughness[,] high strength[,] high elongation rate, and [] excellent glossiness, so that the electrodeposited copper foil may be used in a current collector of a [] battery.” SOLUS-1010, Abstract. Lee also discusses the importance and measurement of “corner curl angle” and “corner curl height.” *Id.*, [0052]; SOLUS-1003, 120.

B. Combination of Kim '761, Cheng, Wolski, and Lee and analysis of [7].

[7]:

The combination of Kim '761, Cheng, Wolski, and Lee renders obvious the claimed corner heights measured according to the recited process. SOLUS-1003, 121. Lee provides ample motivation for a POSITA to try to produce a copper foil having a low measured corner height, for example, disclosing that “when the corner curling phenomenon is generated, a plurality of defects, such as a torn corner, may be generated during a process, such as deposition, in a PCB process, and in a process of the lithium secondary battery, a corner may be torn or folded, or wrinkles may be generated during a coating of an active material.” SOLUS-1010, [0052]. As such, a smaller corner curl height is preferable. *Id.*, 121.

Besides generally motivating a low corner height, Lee provides measured

values for four examples of foils. *Id.*, [0120]. As shown in the annotated table below, of the four examples, two have a corner curl height in the claimed range of “less than 10 mm,” while a third has a corner curl height of 12 mm, close to the claimed range. It would have been obvious to a POSITA to try manufacturing a copper foil having these low, attainable curl heights and other disclosed by Lee, satisfying the range of claim 7 and providing the advantages noted by Lee. SOLUS-1003, 122-123.

TABLE 5		
	Corner curl angle (°)	Corner curl height (mm)
Example 1	5	4
Example 2	15	12
Example 3	8	6
Example 4	30	26
Comparative Example 1	52	48
Comparative Example 2	48	44
Comparative Example 3	46	43
Comparative Example 4	50	46

Annotated Lee Table 5

Lee also provides significant guidance to a POSITA as to how these small corner curl heights may be obtained. SOLUS-1003, 124. For example, Lee provides detailed electrolytic solution compositions for each of the examples and comparative examples, along with plating current and temperature. SOLUS-1010,

[0091]-[0096], Table 1. Dr. Randall discusses that it would have been obvious to employ electrolytic solution compositions and plating conditions similar to those described for Examples 1-3, which have the lowest curl heights disclosed by Lee, in order to obtain low curl heights. SOLUS-1003, 124. He also discusses that the resulting electrolytic solutions would be similar to those used by Kim '761, Cheng, and Wolski, such that a POSITA would have had a reasonable expectation of success in optimizing the curl height and would have been motivated to do so. *Id.*, 124, 134-135.

Although claim 7 does not recite that the “measured heights” are “curl” heights, the '706 Patent makes clear that they are. SOLUS-1003, 125. For example, the '706 Patent describes the measurement of the heights in a section titled “Curls” and states that “the arithmetic mean of the measured heights was taken as the curl.” SOLUS-1001, 8:46-55.

Dr. Randall discusses the '706 Patent's disclosed measurement method (understood to be the method recited in claim 7), and the claimed method, in comparison to the measurement method described by Lee. SOLUS-1003, 126. Dr. Randall notes that, in each case, a portion of copper foil is cut with two intersecting cuts (“a cross” in the '706 Patent or “a shape of ‘X’” in Lee). *Id.* Further, in each case, heights of multiple corners formed by the cuts are measured. *Id.* In addition, the lateral sizes relevant for the measurements are similar (8×8 cm for the '706

Patent and 10×10 cm for Lee). *Id.*

Dr. Randall also demonstrates, based on a close analysis of geometries disclosed in the '706 Patent and Lee, that any differences in the measurement methods of claim 7 and Lee “are not significant enough to lead to substantially different values in measured curl heights.” SOLUS-1003, 127-133.

VII. GROUND 1D: Claims 8-10 are obvious over Kim '761, Cheng, Wolski, Lee, and Shinozaki '681

A. Shinozaki '681

Shinozaki '681 relates to electrodeposited copper foils and their production. SOLUS-1012, [0038]; SOLUS-1003, 136. Shinozaki '681 describes that it can be beneficial to use an electrolyte solution “obtained by mixing an aqueous solution of a metal salt of a metal that exists as an oxide in a solution of pH 4 or lower and an aqueous copper sulfate solution.” SOLUS-1012, [0036].

B. Combination of Kim '761, Cheng, Wolski, Lee, and Shinozaki '681

It would have been obvious to try manufacturing the copper foil of Kim '761, Wolski, and Lee using combinations of the electrolyte chemistries disclosed in those references as well as in Lee and Shinozaki '681, in the amounts disclosed in those references. SOLUS-1003, 137.

“When there is a design need or market pressure to solve a problem and there are a finite number of identified, predictable solutions, a person of ordinary

skill has good reason to pursue the known options within his or her technical grasp. If this leads to the anticipated success, it is likely the product not of innovation but of ordinary skill and common sense. In that instance the fact that a combination was obvious to try might show that it was obvious under § 103.” *KSR* at 421. The electrolyte solutions discussed here and in Sections VIII and XI fall squarely within these “obvious to try” boundaries. The prior art discusses a finite, relatively small number of possible additives known to provide benefits in the manufacture of copper foils. SOLUS-137, 138. The prior art also discusses how those additives affect or correlate with properties of the resulting copper foils, i.e., a recognition of each of the additives as result-effective. And the prior art further discloses amounts of the additives, thereby providing guidance that would lead one of ordinary skill in the art to have a reasonable expectation of success in combining the additives. *Id.* “It is prima facie obvious to combine two compositions each of which is taught by the prior art to be useful for the same purpose, in order to form a third composition which is to be used for the very same purpose.” *In re Kerkhoven*, 626 F.2d 846, 850 (C.C.P.A. 1980). By the same reasoning, it would have been obvious to try using the disclosed additives, in various combinations, for manufacture of copper foils.

In addition, Dr. Randall notes that “the electrolyte solutions employed in each of these five references share the same two primary components: copper ions

(e.g., as provided by copper sulfate), and sulfuric acid. The remaining constituents are additives that are added in smaller amounts to improve various properties of the foil, e.g., its roughness and mechanical characteristics. With the knowledge that the basic compositions of each disclosed solution are the same, it would have been obvious for a POSITA to try varying the additives and their amounts to improve foil properties.” SOLUS-1003, 30-38, 139.

In reference to concentration, under both an “obvious to try” framework and a “routine optimization” framework, it would have been obvious to arrive at the solute/additive amounts described by the ’706 Patent as optimum and claimed in claims 8-10. Because the prior art provides specific amounts that satisfy the claimed ranges and result in desirable copper foil characteristics, it would have been obvious to try using those amounts. SOLUS-1003, 140. It is well-established that optimization of a result-effective variable is obvious. *See, e.g., In re Antonie* at 620; *In re Aller* at 456; *In re Peterson*, 315 F.3d 1325, 1330 (Fed. Cir. 2003).

For these reasons, and for the reasons discussed below with respect to each claim element, it would have been obvious to manufacture the copper foil using an electrolytic solution that includes solutes/additives and solute/additive amounts disclosed by Kim ’761, Cheng, Wolski, Lee, and Shinozaki ’681. SOLUS-1003, 141.

C. Analysis of claims

[8pre]:

As discussed in Section V.C, claim 8, as a product-by-process claim, is obvious because the claimed process has not been demonstrated to result in a non-obvious product. SOLUS-1003, 142.

[8a]:

Kim '761 discloses that “in order for the shiny surface 111a to have a peak count roughness R_{pc} of 10 to 100 and a ten-point mean roughness Rz_{JIS} of 2 μm or less, the surface of the rotational anode drum is **polished with a #800 to #1500 grit polishing brush**.”⁶ SOLUS-1005, [0051]. Kim '761 also presents data showing how roughness values depend on the polishing grit, where specific disclosed examples of the grit include #1200, #1400, #800, and #1000. *Id.*, Table 1. All of these values fall within the claimed range. SOLUS-1003, 143.

Although Kim '761 discloses an “anode drum,” Dr. Randall explains that this reflects a clear and unambiguous error, and that a POSITA would have understood Kim '761 to actually be referring to a cathode drum. SOLUS-1003, 144.

To the extent Kim '761 is not interpreted to explicitly disclose the use and

⁶ Emphasis is added except where noted otherwise.

buffing of a “cathode drum” (or, equivalently, a “negative drum”), each of Cheng, Wolski, and Lee explicitly disclose the use of such a drum, such that the use and buffing of such a drum would have been obvious as a simple substitution of one known element for another to obtain predictable results. SOLUS-1007, 3:56; SOLUS-1008, 1:25; SOLUS-1010, [0037]; SOLUS-1003, 145.

[8b]:

Dr. Randall notes that both [8b] and [8c] are fundamental to the manufacture of electrolytic copper foils. SOLUS-1003, 146. Further, the prior art explicitly discloses this process. For example, Kim ’761 describes that “there is provided a method of producing an electrolytic copper foil by allowing a current to flow between a cathode [understood as anode] plate and a rotational anode [understood as cathode] drum spaced apart from each other in an electrolytic solution so as to electrodeposit a copper on the rotational anode drum.” SOLUS-1005, [0018]. SOLUS-1003, 147.

[8c]:

A POSITA would have understood “winding the electrodeposited foil” to be implied by Kim ’761’s disclosure that the “drum” on which the copper is “electrodeposit[ed]” is “**rotational**.” SOLUS-1003, 148; SOLUS-1005, [0018]. In addition, Cheng describes “continuously winding” the “electrolytic copper foil,” and Wolski describes “the copper foil is wound from a cathode drum.” SOLUS-

1007, 1:58-59; SOLUS-1008, 5:38-40.

[8d]:

In view of the disclosed concentrations below and the reasoning in Section VII.B, the claimed concentrations of copper ions are obvious. SOLUS-1003, 149. Each of the disclosed ranges encompasses or overlaps with the claimed range, and the two disclosed specific values are both within the claimed range. SOLUS-1005, [0049]; SOLUS-1007, 4:45; SOLUS-1008, 8:46; SOLUS-1010, [0085]; SOLUS-1012, [0077]. 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).

Copper Ion Concentration (g/L)					
Claimed range	Kim '761	Cheng	Wolski	Lee	Shinozaki '681
70 – 90	50 – 100	81.4 ⁷	90	60 – 180	50 – 90

[8e]:

In view of the disclosed concentrations below and the reasoning in Section VII.B, the claimed concentrations of sulfuric acid are obvious. SOLUS-1003, 151.

⁷ Dr. Randall provides calculations for converting g/L of copper sulfate to g/L of copper ions. SOLUS-1003, 150.

Two of the three disclosed ranges overlap or encompass the claimed range, and the two disclosed specific values are both within the claimed range. SOLUS-1005, [0049]; SOLUS-1007, 4:45-46; SOLUS-1008, 8:46-47; SOLUS-1010, [0095]; SOLUS-1012, [0077].

Sulfuric Acid Concentration (g/L)					
Claimed range	Kim '761	Cheng	Wolski	Lee	Shinozaki '681
80 – 120	50 – 100	100	110	80 – 150	40 – 70

[8f]:

In view of the disclosures below and the reasoning in Section VII.B, the claimed concentrations of chlorine ions are obvious. SOLUS-1003, 152. Kim '761 describes the use of “**50 ppm or less** of chlorine,” a range which encompasses the claimed range and renders obvious the disclosed range. SOLUS-1005, [0049]. *See In re Peterson* at 1329-30.

Lee discloses the desirability of between 1 and 40 ppm of chlorine ions, and specifically discloses the use of **20 ppm** in the “Example” foils that outperform the “Comparative Example” foils manufactured using 35 or 40 ppm. SOLUS-1007, [0074], Table 1. This would have provided strong motivation for a POSITA to try using 20 ppm, which falls within the claimed range. SOLUS-1003, 152.

Shinozaki '681, too, describes a solution that includes chlorine ions, disclosing that “the [] foil of the present invention is formed [] from an electrolytic solution of sulfuric acid and copper sulfate with low chloride ion concentration []. Here, ‘low chloride ion concentration’ means that the amount of chloride ion in the electrolyte is **15 mg/L**⁸ or less.” SOLUS-1012, [0049]; SOLUS-1003, 153-155. Specific disclosed ion concentrations include, among other values, **10 mg/L** and **15 mg/L**, both of which are within the claimed range. *Id.*, Table 1.

/8g/:

In view of the disclosures below and the reasoning in Section VII.B, the claimed concentrations of a “sulfide-based compound” are obvious. SOLUS-1003, 156.

The '706 Patent describes that “the additive may include at least one sulfide-based compound selected from the group consisting of [] SPS [] MPS [] and [] ZPS[.]” SOLUS-1001, 6:7-11. However, claim 8 does not limit the sulfide-based compounds to these specific compounds. SOLUS-103, 157.

Kim '761 describes that the solution includes “a small amount of organic additive such as [] organic sulfide.” SOLUS-1005, [0049]. Dr. Randall explains

⁸ As Dr. Randall explains “mg/L” is substantially equivalent to “ppm”. SOLUS-1003, 154.

that a POSITA would have understood “organic sulfide” to be a “sulfide-based compound.” SOLUS-1003, 158. Kim ’761 does not explicitly disclose a specific concentration of the organic sulfide.

However, each of Cheng, Wolski, Lee, and Shinozaki ’761 discloses the inclusion of MPS or ZPS, two of the three specific examples of sulfide-based compounds provided by the ’706 Patent. SOLUS-1003, 159. For example, Lee discloses that the inclusion of “additive B,” a “sulfone acid of a compound including a sulfur atom or metallic salt thereof” such as “SPS,” “MPS,” or “ZPS,” can improve surface glossiness. SOLUS-1010, [0073]-[0074], [0081]. Lee discloses a specific example in which **10 ppm of ZPS** is used to obtain desirable low surface roughness, high tensile strength, and high elongation. *Id.*, [0117], Table 1, Table 4. Lee also describes that a range for additive B (e.g., SPS, MPS, or ZPS) of **between 10 and 200 ppm**. *Id.*, [0073], [0075], [0117]. Based on these results, it would have been obvious for a POSITA to optimize within the disclosed range of 10 to 200 ppm and, for example, try using **10 ppm of ZPS** as disclosed by Lee, thereby satisfying the claim’s requirement for “3 to 12 ppm of a sulfide-based compound.” SOLUS-1003, 159.

In addition, Shinozaki ’681 discloses that “the amount of organic additives [] is in the preferred range of **1 ppm to 20 ppm**. More preferably, the amount [] is **1 ppm to 7 ppm**.” SOLUS-1012, [0075]. Among the “organic additives” described

by Shinozaki '681 is **MPS**. *Id.*, [0066], [0091], Table 2. It would further have been obvious to optimize the MPS concentration within the range disclosed by Shinozaki '681 to arrive at an MPS concentration within the claimed range, which is encompassed by Shinozaki '681's range. SOLUS-1003, 160.

[8h]:

Shinozaki '681 renders obvious the claimed concentration of Mo. SOLUS-1003, 161. Shinozaki '681 describes foils having “high conductivity, high tensile strength, and excellent heat resistance can be obtained by [] using an electrolytic solution obtained by mixing **an aqueous solution of a metal salt** [] and an aqueous copper sulfate solution.” SOLUS-1012, [0036]. More specifically, Shinozaki '681 describes that “the metal [] is preferably at least one of W, **Mo**, Ti, or Te.” *Id.*, [0039]. Mo is used in the electrolytic solution of Examples 8, 11, 17, and 18 in the form of sodium molybdate (IV) dihydrate. *Id.*, Tables 1-2. The disclosed concentrations of these metal salts are 40, 400, 80, and 100 mg/L, respectively, corresponding to concentrations of the molybdenum itself of **15.9, 159, 31.7, and 39.7 ppm, respectively**. *Id.*, Tables 1-2; SOLUS-1003, 161. That is, two out of the four molybdenum-incorporating solutions of Shinozaki '681 have a molybdenum concentration in the claimed range.

It would have been obvious for a POSITA to incorporate Mo into a modified electrolyte solution, employing the concentrations used by Shinozaki '681, in order

to realize the “high conductivity, high tensile strength, and excellent heat resistance” disclosed by Shinozaki ’681. SOLUS-1003, 162; SOLUS-1012, [0035], [0036], [0038]. This combination would have entailed nothing more than pursuing one of the finite number of identified, predictable additives disclosed by Shinozaki ’681, with the concentration disclosed by Shinozaki ’681. Framed another way, the combination would have involved simply applying a technique known to improve the devices of Shinozaki ’681 – the inclusion of molybdenum in the electrolytic solution, with particular concentrations – to the electrolyte solution of Kim ’761, Cheng, Wolski, and Lee.

Dr. Randall notes that “the electrolytic solutions used by Shinozaki ’681 include copper ions, sulfuric acid, chlorine ions, and an organic additive such as MPS. That is, these electrolytic solutions are quite similar to those described by ’Kim ’761, Cheng, Wolski, and Lee, and similar to the proposed modified electrolytic solution discussed herein with respect to claim 8.” SOLUS-1003, 163. “Based on these similarities, a POSITA would have had a reasonable expectation that molybdenum incorporated into the modified electrolytic solution would have a similar effect to molybdenum incorporated into Shinozaki ’681’s solutions.” *Id.*

Therefore, and as set forth in Section VII.B, the inclusion of molybdenum in the recited concentrations would have been obvious. SOLUS-1003, 164.

/8i/:

Lee and Cheng render obvious the claimed concentration of PEG. Each of the four examples disclosed by Lee includes **20 ppm** of PEG, suggesting that PEG should be included in the electrolytic solution at this concentration (within the claimed range) in order to obtain the high-quality copper foils produced by Lee, which have desirable mechanical properties, surface properties, and curl properties. SOLUS-1010, [0006], [0121], Table 1; SOLUS-1003, 165.

Cheng notes that “[t]raditionally, an organic additive, such as polyethylene glycol (PEG)” is added “in order to reduce the roughness of the M side of the electrolytic copper foil.” SOLUS-1007, 2:1-2, 3:65-4:1. Based on this teaching, it would have been obvious to a POSITA to try including PEG in the electrolytic solution, with the 20 ppm concentration disclosed by Lee, in order to tune matte-side surface roughness. SOLUS-1003, 166.

[9]:

As discussed in reference to [8g] above, it would have been obvious to use SPS, MPS, or ZPS as the sulfide-based compound having concentration 3 to 12 ppm. SOLUS-1003, 167. For example, Lee describes the use of **10 ppm of ZPS**. SOLUS-1010, Table 1.

[10]:

In view of Lee, it would have been obvious to include SPS in the electrolytic solution with a concentration of 3 to 12 ppm. SOLUS-1003, 168. As discussed

above in reference to [8g], Lee discloses the use of **10 ppm of ZPS** to improve surface glossiness. SOLUS-1010, [0074], [0117], Table 1, Table 4.

Dr. Randall discusses that “ZPS is one of a class of sulfur-containing compounds (accelerators) that are often used interchangeably in electrolytic solutions for copper foil manufacture. [] Indeed, Lee discloses that ‘the sulfone acid [additive B] may be one or more selected from the group consisting of [] SPS [,] MPS [,] DPS [,] UPS [,] OPX [,] **ZPS**’ and several others. SOLUS-1010, [0073], [0081]. [] Based on this and general knowledge in the art [*see* SOLUS-1003, 37], a POSITA would have understood Lee to be describing that SPS, MPS, and ZPS, among other compounds, [] may be used substantially interchangeably, and as equivalents to one another, in order to maintain surface glossiness and obtain a desired matte side surface roughness.” SOLUS-1003, 168.

Based on this disclosure, it would have been obvious for a POSITA to try using SPS instead of ZPS, with the same 10 ppm concentration disclosed by Lee. SOLUS-1003, 169. It is *prima facie* obvious to substitute, for one component, another that the art has recognized as equivalent for the same purpose. *See, e.g., In re Ruff*, 256 F.2d 590, 592, 596 (C.C.P.A. 1958).

VIII. GROUND 1E: Claim 10 is obvious over Kim '761, Cheng, Wolski, Lee, Shinozaki '681, and Dobashi

A. Dobashi

Dobashi relates to “a surface-treated electro-deposited copper foil” having desirable surface characteristics. SOLUS-1014, Abstract. Among the surface parameters discussed is RSm, and Dobashi discloses that “RSm (JIS B 0601, 2001) obtained by using the stylus-type roughness meter can be adopted as the period of waviness, RSm can also be used as an indicator for judgment of the surface. The surface has small waviness and is smooth when RSm is large, and the surface has large waviness and is rough when RSm is small.” *Id.*, 6:24-29. Dobashi describes the desirability of performing copper deposition in an electrolytic solution that “preferably comprises at least one selected from MPS and SPS,” and that MPS and/or SPS can advantageously cause the matte side of the copper foil to be smooth. *Id.*, 11:60-12:13; SOLUS-1003, 170.

B. Combination of Kim '761, Cheng, Wolski, Shinozaki '681, Lee, and Dobashi and analysis of claim 10

[10]:

Claim 10 is obvious in view of Lee, as discussed in Section VII.C. To the extent Lee fails to disclose any specific examples in which SPS is used with a concentration from 3 and 12 ppm, Dobashi discloses the incorporation of SPS in that range. SOLUS-1003, 171. Dobashi recognizes the equivalence of **both** “MPS

and/or SPS” for obtaining desired surface roughness. SOLUS-1014, 12:1-5.

Dobashi further describes that the “MPS and/or SPS” should be included in a range from “0.5 ppm to 200 ppm” and “preferabl[y] [] **1 ppm to 20 ppm**,” and provides examples of electrolytic solutions in which SPS is included with concentrations of 5 and 6 ppm. *Id.*, 11:65, Table 1. Accordingly, and for reasons discussed in Section VII.B, it would have been obvious, in view of Dobashi, to use SPS as the sulfide-based compound having a concentration of 3 to 12 ppm. SOLUS-1003, 171.

IX. GROUND 2A: Claims 1-5 are obvious over Dobashi, Shinozaki '922, and Chou

A. Chou

Chou relates to an “electrodeposited copper foil” having certain crystal plane texture coefficients. SOLUS-1016, Abstract. Those texture coefficients are associated with reduced nodule count, “excellent tensile strength and rate of elongation,” and desirable surface roughness. *Id.*, [0049]. SOLUS-1003, 172.

B. Shinozaki '922

Shinozaki '922 relates to “an electrolytic copper foil” in which “the Rz difference between the front and back surfaces [is] within 3 μm and the Ra differences between the front and back surfaces [is] within 0.3 μm .” SOLUS-1015, Abstract; SOLUS-1003, 173. These copper foils (including in the as-deposited form) have advantageous tensile strengths and elongations, and the small difference in roughness between their two sides is advantageous for subsequent

treatment. *Id.*, [0049]-[0050].

C. Combination of Dobashi, Shinozaki '922, and Chou

It would have been obvious to a POSITA to apply the teachings of Shinozaki '922 and Chou to the copper foil of Dobashi ("Dobashi-Shinozaki '922-Chou"), to obtain modified copper foils having (i) the mean profile width R_{Sm} (and, correspondingly, $|\Delta PD|$) of Dobashi, (ii) the R_z/R_a ratios of Shinozaki '922, and (iii) the (220) texture coefficients of Chou. SOLUS-1003, 174. The reasoning here is substantially similar to that provided in Section IV.D. *See also* SOLUS-1003, 175.

1. R_z/R_a

Regarding R_z/R_a , Shinozaki '922 describes the desirability of having "the difference of roughening [roughness] between the two surfaces in the state of the untreated copper foil [be] small," and Shinozaki '922 focuses specifically on R_z and R_a as the two roughness parameters of interest. SOLUS-1015, [0046], [0048]; SOLUS-1003, 176. For example, Shinozaki '922 describes that "untreated copper foil with roughnesses R_z of both surfaces [] of a low 0.8 μm to 2.0 μm is employed" and (in reference to treated foils "a difference of a roughness between the roughnesses R_z of the front and back surfaces being within 3 μm or a difference of a roughness between the roughnesses R_a of the front and back surface being within 0.3 μm ." *Id.*, [0035], [0054]. These characteristics are associated with

improved battery performance. *Id.*, [0055]-[0056], [0074], [0116]. Further, Shinozaki '922 provides a clear roadmap for obtaining these Rz and Ra values, disclosing the electrolyte compositions and deposition conditions that produce copper foils with these parameters. *Id.*, [0088]-[0089], Table 1.

Accordingly, and for reasons discussed in Section IV.D and Section IX.C above, it would have been obvious for a POSITA to optimize Rz and Ra to have the values in Table 2 of Shinozaki '922. As a result, the POSITA would have also arrived at the Rz/Ra ratios taught by Shinozaki '922. SOLUS-1003, 177.

2. TC(220)

Regarding TC(220), Chou makes clear (i) that texture coefficients in general are important parameters for determining foil quality, and (ii) that the particular combinations of texture coefficients obtained for Chou's Examples 1-10 foils result in favorable roughness, mechanical, and nodule properties compared to foils having different texture coefficients. SOLUS-1016, [0049], Tables 1-2. SOLUS-1003, 178. As such, it would have been obvious for a POSITA to optimize the foil texture coefficients so as to attain a combination of texture coefficients matching that of Examples 1-10. *Id.* Dr. Randall notes further that optimization of a primary parameter of interest in Chou (the ratio of TC(200) to the sum of TC(111), TC(200), TC(220), and TC(311)) "would have necessarily involved consideration of and modulation of TC(220), which appears in the denominator of

the quantity.” SOLUS-1016, [0034], Table 1; SOLUS-1003, 179. And, to the extent these teachings were insufficient for a POSITA to recognize TC(220) as result-effective, Dr. Randall notes that “the POSITA would have also been aware of disclosures in Cheng, Kim ’541, and Song that more directly note the importance of TC(220) for foil quality.” SOLUS-1003, 180. As such, it would have been obvious for a POSITA to optimize TC(220) to have a value taught by Chou (e.g., any of the values of Examples 1-7 and 9-10, which satisfy the range of claim 1), with a reasonable expectation of success for reasons described by Dr. Randall and similar to those provided in Section IV.D. SOLUS-1003, 181-183.

3. Analysis of RSm

Dobashi discusses the importance of “RSm” as defined in the JIS B 0601 (2001) standards. SOLUS-1014, 6:13-29. RSm is tightly linked to peak density PD. As Dr. Randall explains, “RSm is essentially a measure of the average spacing between peaks []. PD (or R_{pc} or P_c), on the other hand, tells us how many peaks exist per unit length. [] That is, RSm and PD contain the same information but express it inversely from one another.” SOLUS-1003, 184.

Based on this recognition, and as described in more mathematical detail in his Declaration, Dr. Randall has converted the RSm values disclosed by Dobashi into PD values that can be compared directly to those of the ’706 Patent. SOLUS-1003, 185. These converted values are utilized and noted below.

Dr. Randall also notes that both Rsm and PD require the selection of criteria above/below which the surface profile must pass in order to count as a “peak.” SOLUS-1003, 186. Dobashi does not explicitly disclose these discrimination lines, making a one-to-one comparison between Dobashi’s Rsm/PD and the ’706 Patent’s disclosed PD more challenging (the ’706 Patent uses discrimination lines of $\pm 0.5 \mu\text{m}$). SOLUS-1001, 8:36-45; SOLUS-1003, 186.

However, Dr. Randall notes that the JIS B 0601 (2001) standard, according to which Dobashi’s Rsm is calculated, teaches that, “[i]f not otherwise specified, the **default height discrimination shall be 10 % of [] Rz.**” SOLUS-1022, 14; SOLUS-1003, 187. According to that standard, Rz (not to be confused with the ten-point roughness that often shares the same symbol) is the “maximum height of profile.” SOLUS-1022, 10. Dobashi discloses this parameter as PV, the “maximum peak to valley height.” SOLUS-1014, 7:55. Using the disclosed PV, Dr. Randall can put upper limits on the PD values corresponding to Dobashi’s Rsm values, as explained in further detail in his Declaration. SOLUS-1003, 187-189.

D. Analysis of claims

[1pre]:

To the extent the preamble is limiting, the modified Dobashi-Shinozaki’922-Chou copper foil discussed in Section IX.C satisfies or renders obvious an electrolytic copper foil having a first surface and a second surface. SOLUS-1003,

190. For example, Dobashi discloses an “electro-deposited copper foil” having a “shiny side” and a “deposit side.” SOLUS-1014, 3:39-46.

[1a]:

The Dobashi-Shinozaki’922-Chou foil, having TC(220) values such as those disclosed by Chou, satisfies or renders obvious a TC(220) of 0.4 to 1.32. Of Chou’s ten examples, **nine** have a TC(220) within the claimed range; the TC(220) as a whole span a range of 0.33 to 0.7. SOLUS-1016, Table 1; SOLUS-1003, 191. Based on this disclosure, in which nearly all of the explicit values are in the recited range and which corresponds to a range overlapping with the claimed range, it would have been obvious to make a copper foil having a TC(220) in the claimed range, for reasons discussed in Section IX.C and similar reasons to those provided in Sections IV.D-E. SOLUS-1003, 191.

[1b]:

The Dobashi-Shinozaki’922-Chou foil, having Rz and Ra values such as those disclosed by Shinozaki ’922, satisfies or renders obvious a $|\Delta(Rz/Ra)|$ of less than 2.42. As shown in Shinozaki ’922’s Table 2 below, all manufactured foils have $|\Delta(Rz/Ra)|$ well below the claimed upper limit of 2.42. Based on this disclosure, it would have been obvious to make a copper foil having a $|\Delta(Rz/Ra)|$ in the claimed range, for reasons discussed in Section IX.C and similar reasons to those provided in Sections IV.D-E. SOLUS-1003, 192.

Untreated		<u>Ra (μm)</u>		<u>Rz (μm)</u>		$ \Delta(Rz/Ra) $
copper foil	Thickness (μm)	S surface	M surface	S surface	M surface	
A1	10.0	0.27	0.28	1.5	1.3	0.91
A2	10.0	0.27	0.20	1.5	0.8	1.60
A3	10.0	0.27	0.30	1.5	2.0	1.10
B1	10.0	0.27	0.42	1.5	2.6	0.63
B2	10.0	0.27	0.30	1.5	1.9	0.78
B3	10.0	0.27	0.26	1.5	1.4	0.17

Modified Shinozaki '922 Table 2

[1c]:

The Dobashi-Shinozaki'922-Chou foil, having RSm values such as those disclosed by Dobashi, renders obvious a $|\Delta PD|$ of 96 ea or less. First, as noted above in Section IX.C and as explained in more detail in Dr. Randall's Declaration, Dr. Randall performed straightforward calculations to convert Dobashi's matte side (deposit side) RSm into a matte side PD. SOLUS-1003, 193-194. The resulting PD values are shown in the modified Dobashi Table 2 below.

TABLE 2										
Deposit side of electro-deposited copper foil										
Copper foil	Three-dimensional surface structure analysis			Stylus-type roughness meter		Gloss Gs		Deposit side PD	Default discrimination criteria (um)	
	thickness	Wmax	PV	Wmax/PV	Rzjis	RSm	(60°)			
Subject	(μm)	(μm)	(μm)	(-)	(μm)	(mm)	TD	MD		
Example 1	15	0.37	0.39	0.949	0.32	0.19	659	665	21.1	0.039
Example 2	12	0.45	0.48	0.938	0.31	0.16	664	671	25.0	0.048
Example 3	70	0.065	0.079	0.823	0.17	0.39	691	686	10.3	0.008
Example 4	15	0.27	0.30	0.904	0.29	0.18	790	790	22.2	0.030
Example 5	15	0.36	0.39	0.943	0.31	0.16	775	773	25.0	0.039
Example 6	12	0.42	0.44	0.959	0.47	0.22	654	687	18.2	0.044
Example 7	12	0.58	0.66	0.869	0.71	0.14	608	640	28.6	0.066
Comparative Example	12	0.82	1.87	0.439	1.00	0.07	324	383		

Modified Dobashi Table 2

Although Dobashi effectively discloses matte side PD, Dobashi does not explicitly discuss the shiny side PD. However, it would have been obvious to make the shiny side PD lower than or similar to the matte side PD, such that $|\Delta PD|$ would be 96 ea or less. SOLUS-1003, 195. Motivation for that configuration would have been provided at least by Shinozaki '922's disclosure that it is desirable for the "difference of roughening between the two surfaces in the state of the untreated copper foil [to be] made small." SOLUS-1015, [0048]. Dr. Randall also provides various other art documents attesting to the desirability of having similar roughness between the two sides of the foil. SOLUS-1003, 72. Following this direction, it would have been obvious for a POSITA to make the shiny side with a PD equal to

or less than the matte side PD, which, as Dr. Randall notes, would necessarily satisfy element [1c], because the PD for the matte side is less than 96 ea for all examples of Dobashi. SOLUS-1003, 195. The same motivation would have made it obvious to, if not make the shiny side with the same or a smaller PD, at least make the shiny side with a PD **close** to the matte side PD, e.g., in a range from 0 to 117 for Example 1, from 0 to 121 for Example 2, etc., ranges of values that would satisfy this element of claim 1. SOLUS-1003, 196.

Moreover, as discussed in Section V.C above, shiny side roughness characteristics can be tuned easily and arbitrarily by adjusting the surface of the cathode drum. SOLUS-1003, 27-29. Accordingly, it would have been well within the skill of a POSITA to make the shiny side PD less than or similar to the matte side PD, with a reasonable expectation of success, to arrive at $|\Delta PD|$ of 96 ea or less. SOLUS-1003, 197.

Finally, to the extent the foregoing discussion fails to demonstrate the obviousness of making the shiny side PD similar to the matte side PD to obtain a PD difference of 96 or less, this element would have been obvious in view of Kim '761's explicit teaching of this characteristic. SOLUS-1003, 198. *See* Section IV.E.

[2] and [3]:

The Dobashi-Shinozaki '922-Chou foil, having Rz and Ra values such as disclosed by Shinozaki '922, satisfies or renders obvious each of claims 2 and 3.

As shown in the table below, of Shinozaki '922's six examples of foils, all of them satisfy the Rz/Ra range recited in claim 3, and all except one satisfy the Rz/Ra range recited in claim 2. The sole value not satisfying that range differs from it by only 5%. SOLUS-1003, 199. For reasons discussed in Section IX.C and similar reasons to those provided in Sections IV.D and IV.E, it would have been obvious to make the Dobashi-Shinozaki'922-Chou foil with Rz/Ra ratios matching or similar to those of Shinozaki '922, thus rendering obvious claims 2 and 3. SOLUS-1003, 199-200.

Untreated copper foil	Thickness (μm)	<u>Ra (μm)</u>		<u>Rz (μm)</u>		M surface Rz/Ra	S surface Rz/Ra
		S surface	M surface	S surface	M surface		
A1	10.0	0.27	0.28	1.5	1.3	4.6	5.6
A2	10.0	0.27	0.20	1.5	0.8	4.0	5.6
A3	10.0	0.27	0.30	1.5	2.0	6.7	5.6
B1	10.0	0.27	0.42	1.5	2.6	6.2	5.6
B2	10.0	0.27	0.30	1.5	1.9	6.3	5.6
B3	10.0	0.27	0.26	1.5	1.4	5.4	5.6

Modified Shinozaki '922 Table 2

[4] and [5]:

The Dobashi-Shinozaki'922-Chou combination renders obvious the tensile strength and elongation of claims 4 and 5. Shinozaki '922 and Chou disclose both of these parameters, measured at room temperature, for ten and six different examples of foils, respectively. SOLUS-1016, [0042]-[0043], Table 1; SOLUS-

1015, Table 2. Across these two references together, all sixteen examples satisfy the recited ranges for both the tensile strength and the elongation. SOLUS-1003, 201. For reasons similar to those discussed with respect to [4] and [5] in Section IV.E, it would have been obvious for a POSITA to arrive at the recited values by routine experimentation and optimization based on the disclosures of Shinozaki '922 and Chou. SOLUS-1003, 201.

X. GROUNDS 2B and 2C: Claims 6 and 7 are obvious over Dobashi, Shinozaki '922, Chou, and Lee or Kim '541

A. Analysis of claims

[6] and [7]:

For reasons similar to those provided in Sections V and VI, claim 6 is obvious over Dobashi-Shinozaki'922-Chou further in view of Kim '541, and claim 7 is obvious over Dobashi-Shinozaki'922-Chou further in view of Lee. SOLUS-1003, 202. As discussed for Grounds 1B-1C, Lee and Kim '541 provide detailed process parameters to be used for achieving lateral weight deviation and corner heights in the recited ranges. SOLUS-1003, 110-112, 121-135, 202. Moreover, the general similarities between the processes and electrolytic solutions of Lee/Kim '541 and Dobashi, Shinozaki '922, and Chou would have provided a POSITA with a reasonable expectation of success in achieving the recited values. SOLUS-1003, 202.

XI. GROUND 2D: Claims 8-10 are obvious over Dobashi, Shinozaki '922, Chou, Lee, and Shinozaki '681

A. Analysis of claims

For the reasons discussed in Section VII.B, it would have been obvious to try using a modified electrolyte solution including combinations of the various solutes/additives described by the prior art, with the concentrations described by the prior art, to obtain the advantageous copper foils produced by the prior art using those chemistries. SOLUS-1003, 203.

[8pre] and [8a]:

At least Dobashi's disclosure that "[i]n preparation of an electro-deposited copper foil, electrolysis was performed by using a rotating cathode made of a titanium plate in which the surface was polished by #2000 emery paper" renders obvious these elements. SOLUS-1014, 16:28-31; SOLUS-1003, 204.

[8b] and [8c]:

These elements are obvious at least in view of Dobashi's disclosure that "a sulfuric acid base copper electrolytic solution is supplied to the gap between a drum-shaped rotating cathode and a lead base anode or dimensionally stable anode (DSA) located opposed along the shape of the rotating cathode. Copper is electro-deposited on the surface of the rotating cathode, and the deposited copper is continuously peeled off as a foil from the rotating cathode and wound." SOLUS-

1014, 8:51-58; SOLUS-1003, 205.

[8d]:

The following disclosures render obvious 70 to 90 g/L of copper ions.

SOLUS-1003, 206; SOLUS-1014, 16:5; SOLUS-1015, Table 1; SOLUS-1016, [0035]; SOLUS-1010, [0085]; SOLUS-1012, [0077].

Copper Ion Concentration (g/L)					
Claimed range	Dobashi	Shinozaki '922	Chou	Lee	Shinozaki '681
70 – 90	80	90	80	60 – 180	50 – 90

[8e]:

The following disclosures render obvious 80 to 120 g/L of sulfuric acid.

SOLUS-1003, 207. SOLUS-1014, 16:6; SOLUS-1015, Table 1; SOLUS-1016, [0035]; SOLUS-1010, [0095]; SOLUS-1012, [0077].

Sulfuric Acid Concentration (g/L)					
Claimed range	Dobashi	Shinozaki '922	Chou	Lee	Shinozaki '681
80 – 120	140	100	110	80 – 150	40 – 70

[8f]:

At least the following disclosures render obvious 10 to 20 ppm of chlorine

ions. SOLUS-1003, 208.

Shinozaki '681 describes a solution that includes chlorine ions, disclosing that “the [] foil of the present invention is formed [] from an electrolytic solution of sulfuric acid and copper sulfate with low chloride ion concentration []. Here, ‘low chloride ion concentration’ means that the amount of chloride ion in the electrolyte is **15 [ppm] or less.**” SOLUS-1012, [0049]. Specific disclosed ion concentrations include, among other values, **10 ppm and 15 ppm**, both of which are within the claimed range. *Id.*, Table 1; SOLUS-1003, 209.

Dobashi discloses various chlorine concentrations, including an example in which the concentration is **10 ppm**. SOLUS-1014, Table 1. SOLUS-1003, 210.

[8g]:

At least the following disclosures render obvious 3 to 12 ppm of a sulfide-based compound. SOLUS-1003, 211.

Chou discloses that “[t]o every liter of the copper sulfate electrolyte [] **3 mg of [] MPS []** were added.” SOLUS-1016, [0035]. 3 mg/L corresponds to **3 ppm**. SOLUS-1003, 212. MPS is listed by the '706 Patent as a sulfide-based compound. SOLUS-1001, 2:52-57.

Shinozaki '922 discloses examples of MPS concentration of **3 ppm, 5 ppm, and 10 ppm**. SOLUS-1015, Table 1; SOLUS-1003, 213.

Dobashi discloses that “[i]t is also preferable that the total concentration of

MPS and/or SPS in the sulfuric acid base copper electrolytic solution is **0.5 ppm to 200 ppm**” and that “a further preferable concentration range is **1 ppm to 20 ppm**” SOLUS-1014, 4:22-24, 11:60-67; SOLUS-1003, 214.

[8h]: See discussion of Shinozaki '681 in [8h] in Section VII.C. SOLUS-1003, 215.

[8i]: See discussion of Lee in [8i] in Section VII.C. SOLUS-1003, 216.

[9]: See [9] in Section VII.C. SOLUS-1003, 217.

[10]: See [10] in Sections VII.C and VIII.B. SOLUS-1003, 218.

XII. 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.

XIII. DISCRETIONARY CONSIDERATIONS

A. §314(a)

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

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

Factor 2 is neutral based on an expected Final Written Decision (FWD) date in March 2026, which is within four months of the currently scheduled trial date of November 3, 2025. *See* SOLUS-1046. Moreover, Solus’s Motion to Transfer that was filed on June 12, 2024, if successful, will help ensure that the FWD outpaces any trial date, based on the actual schedule or the median time-to-trial. *See* SOLUS-1047.

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

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

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

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

B. 35 U.S.C. §325(d)

Discretionary denial under *Advanced Bionics* is not warranted.

The references applied against claim 1 – Kim ’761, Cheng, Wolski, Dobashi, Chou, and Shinozaki ’922 – were not applied in rejections during prosecution of

the '706 Patent. *See* SOLUS-1002. Indeed, no art rejections were issued during the prosecution.

The Examiner's failure to apply these references during prosecution was erroneous, such that part 2 of the *Advanced Bionics* framework is not satisfied. Although Cheng and Chou were identified during prosecution (SOLUS-1002, 438) and are listed on the face of the '706 Patent, the Examiner erred in failing to use these references in a rejection. Nor did the Examiner identify Kim '761 or Dobashi or recognize that these references teach the PD-related limitation of claim 1. The omission of these references from any applied rejection and failure to consider their teachings constitutes material error.

XIV. FEES

Please charge Deposit Account No. 06-1050 for any fees.

XV. CONCLUSION

The Challenged Claims should be canceled.

XVI. 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 '706 Patent. The '706 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.

Lead Counsel	Backup counsel
Timothy W. Riffe, Reg. No. 43,881 Fish & Richardson P.C. 60 South Sixth Street Minneapolis, MN 55402 Tel: 202-783-5070 Fax: 877-769-7945 Email: IPR57533-0004IP1@fr.com	Hyun Jin In, Reg. No. 70,014 Alexander Berg, Reg. No. 79,866 Fish & Richardson P.C. 60 South Sixth Street Minneapolis, MN 55402 Tel: 202-783-5070 Fax: 877-769-7945 Email: IPR57533-0004IP1@fr.com

D. Service Information

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

Petitioner consents to electronic service by email at IPR57533-0004IP1@fr.com.

Respectfully submitted,

Dated: September 20, 2024

/Timothy W. Riffe/
Timothy W. Riffe, Reg. No. 43,881
Hyun Jin In, Reg. No. 70,014
Alexander Berg, Reg. No. 79,866
Fish & Richardson P.C.
60 South Sixth Street
Minneapolis, MN 55402
T: 202-783-5070
F: 877-769-7945

(Control No. IPR2024-01463)

Attorneys for Petitioner

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 13,903 words, which is less than the 14,000 allowed under 37 CFR § 42.24.

Dated: September 20, 2024

/Timothy W. Riffe/

Timothy W. Riffe, Reg. No. 43,881

Hyun Jin In, Reg. No. 70,014

Alexander Berg, Reg. No. 79,866

Fish & Richardson P.C.

60 South Sixth Street

Minneapolis, MN 55402

T: 202-783-5070

F: 877-769-7945

(Control No. IPR2024-01463)

Attorneys for Petitioner

CERTIFICATE OF SERVICE

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

K&L Gates LLP-Chicago
P.O. Box 1135
Chicago, IL 60690
(312) 372-1121

/Crena Pacheco/
Crena Pacheco
Fish & Richardson P.C.
60 South Sixth Street
Minneapolis, MN 55402
pacheco@fr.com