

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

ZHUHAI COSMX BATTERY CO., LTD.,
Petitioner

v.

NINGDE AMPEREX TECHNOLOGY LIMITED,
Patent Owner

Case IPR2025-00385
U.S. Patent No. 10,964,927

**PETITION FOR *INTER PARTES* REVIEW
OF U.S. PATENT NO. 10,964,927**

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1001	U.S. Patent No. 10,964,927
1002	File History of U.S. Patent No. 10,964,927
1003	Declaration of Dr. Michael Pecht
1004	U.S. Patent Application Publication No. 2015/0180002 to Nishikawa et al. (“Nishikawa”)
1005	Chen et al., “Deformation and fracture behaviors of microporous polymer separators for lithium ion batteries” <i>RSC Advances</i> (March 2014) (“Chen”)
1006	U.S. Patent No. 10,559,802 to Zhang et al. (“Zhang”)
1007	Zhang, “Mechanical Behavior of Shell Casing and Separator of Lithium-ion Battery” <i>Massachusetts Institute of Technology</i> (June 2017) (“Zhang Thesis”)
1008	Certified English-language Translation of Prosecution History of Chinese Patent Application No. CN201810640157.9A
1009	<i>Curriculum Vitae</i> of Michael Pecht
1010	Jordan, J.L., et al., “Mechanical Properties of Low Density Polyethylene,” <i>Journal of Dynamic Behavior of Materials</i> , 2:411-420 (2016)
1011	Salakhov, I.I., “Low-Temperature Mechanical Properties of High-Density and Low-Density Polyethylene and Their Blends,” <i>Polymers</i> , 13(1821):1-21 (2021)
1012	Carr, S.H., et al., “Structural Basis for the Mechanical Properties of Polyethylenes,” Department of Defense (1983)
1013	Complaint, <i>Ningde Ampere Tech. Ltd. v. Zhuhai CosMX Battery Co.</i> , No. 2:24-cv-00728-JRG (E.D. Tex. Sept. 6, 2024), ECF 1

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Exhibit No.	Description
1014	Unopposed Application for Extension of Time to Answer Complaint, <i>Ningde Amperex Tech. Ltd. v. Zhuhai CosMX Battery Co.</i> , No. 2:24-cv-00728-JRG (E.D. Tex. Dec. 4, 2024), ECF 16
1015	Arora et al., “Battery Separators” <i>Chem Rev.</i> (Oct. 2004)
1016	EP Patent Application No. 0924780 A1 to Yu
1017	Xiong, B., “Contribution to the study of elastic and plastic deformation mechanisms of polyethylene and polypropylene as a function of microstructure and temperature,” <i>Materials</i> (2014)
1018	Beer, F., et al. “Mechanics of Materials” (2009)
1019	Baldwin, R.S., “Properties and Performance Attributes of Novel Co-extruded Polyolefin Battery Separator Materials” (2011)
1020	Dupen, B., “Applied strength of Materials for Engineering Technology,” Vol.11 (Revised January 2017)
1021	Hibbeler, R.C., “Mechanics of Materials,” 8th Ed. (2011)

I. INTRODUCTION

Zhuhai CosMX Battery Co., Ltd. (“Petitioner”) petitions for *Inter Partes* Review (“IPR”), seeking cancellation of claims 1-10 of U.S. Patent No. 10,964,927 (“the ’927 patent”), assigned to Ningde Amperex Technology Ltd. (“PO”). These claims are unpatentable under AIA 35 U.S.C. §§ 102 and/or 103 in view of the prior art.

The claims of the ’927 patent are directed to a battery that one might find in a consumer electronic device, like a cell phone, laptop computer, or motor. EX1001, 1:45-56. Like all batteries, the claimed batteries have an anode (negative electrode) and cathode (positive electrode) with a separator in between. *Id.* The separator is made from a porous polymer film (called a substrate) which enables ions from the anode and cathode to flow through. *Id.* The substrate is coated with a layer that contains inorganic particles and a binder. *Id.* The polymer, inorganic particles, and binder can be made of any of numerous materials well known for those purposes. Nothing about the composition of the separator (or the battery as a whole) is alleged to be novel. Rather, the Specification suggests that the alleged invention lies in the identification of an optimal plastic deformation rate for the polymer film. EX1001, 1:54-65.

The ’927 patent explains that batteries carry a risk of fire or explosion if a conductive object punctures the separator and thereby shorts the circuit between

the anode and cathode. EX1001, 3:67-4:5. When any polymer material (like a separator) is subjected to a force, it first undergoes an elastic deformation (a stretch from which it will bounce back), followed by a plastic deformation (a stretch from which it will not recover), followed finally by a fracture (break). *Id.* The '927 patent hypothesizes that when the absolute plastic deformation rate (the amount of stretch that remains after breaking) and/or the relative plastic deformation rate (the percentage plastic deformation compared to elastic deformation) of the polymer film are within a certain range, the separator will envelope a nail driven into the battery and prevent the nail from shorting the circuit. EX1001, 1:34-44. The patent uses this nail test as a proxy for the general safety of the battery. *Id.*

Using separator deformation to protect against short-circuiting due to punctures was nothing new with the '927 patent. The prior art analyzed this subject and a variety of parameters concerning separators' deformation properties as well as their known inter-relationships. The '927 patent appears to relabel two well-known properties as a "rate" reciting "absolute plastic deformation rate" and "relative plastic deformation rate" to give the appearance that these properties are not appreciated in the prior art. EX1001, 1:34-44.

As explained in the prior art, when an object is subjected to force stretching it in a direction (referred to as stress), it experiences two fundamental forms of elongation (the length of which is referred to as "strain") before breaking. First,

there is an amount of elongation from which the object will recover and return to its original length: elastic strain. This behavior is governed by Hooke's Law, which states that stress is proportional to strain within the elastic limit. Second, there is elongation from which an object will not recover: plastic strain. The total elongation or strain an object experiences from its original length before breaking is therefore the sum of its elastic strain and its plastic strain. What the '927 patent claims recite as "absolute plastic deformation rate" is simply the percentage of a separator's plastic strain when stretched to its breaking point relative to its original, unstretched length. EX1001, 4:15-21. Nothing in this formulation was new with the '927 patent.

The prior art's analysis of separator deformation addresses a range of parameters and relationships including, and beyond, those encompassed by the '927 patent's "absolute plastic deformation rate." The connection between (a) the plastic deformation rate of a polymer film and (b) a battery separator's ability to prevent short circuiting in the event of penetration by a conductive object, to the extent one exists, is merely an observation about how known battery materials work. The "rate" is a way of describing a particular innate property of common battery separator materials.

Importantly, the claimed plastic deformation rates and the recited way in which they are measured is not a method step that must be performed. The claim

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merely recites a laundry list of well-known battery separator materials, and observes a desired plastic deformation rate. All of the recited battery separator materials and their properties (including plastic deformation rates) were known in the art. In that regard, known battery separators that were known to reliably pass the nail penetration test (50% or higher passage rate) necessarily had plastic deformation rates within the claimed ranges. Accordingly, the claims were anticipated and/or rendered obvious by the prior art.

II. GROUNDS FOR STANDING (37 C.F.R. § 42.104(a))

Petitioner certifies that the '927 patent is available for IPR and Petitioner is not barred or estopped from requesting IPR of any challenged claim.

III. PRECISE RELIEF REQUESTED (37 C.F.R. §42.22(a)) AND IDENTIFICATION OF CHALLENGE (37 C.F.R. § 42.104(b))

The Board should institute IPR under 35 U.S.C. §§ 311-319 and 37 C.F.R. §§ 42.1-42.80 and 42.100-42.123, and cancel all the '927 patent claims as unpatentable under AIA 35 U.S.C. §§ 102(a)(2) and 103 in view of the following combination of references: ¹

Ground	35 U.S.C. §	Claims	References
1	102(a)(2)	1-10	Nishikawa (Exhibit 1004)

¹ Reference citations are “EX___,” followed by page, paragraph, or column and line numbers.

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Ground	35 U.S.C. §	Claims	References
2A/2B	103	1-10	Nishikawa; Nishikawa in view of Chen (Exhibit 1005)
3	103	1-10	Chen in view of Zhang (Exhibit 1006)

This Petition is supported by the expert declaration of Michael Pecht, Ph.D., P.E., an expert in the field of battery materials, construction and operation, manufacture, testing, and reliability and safety. *See generally* EX1003. Petitioner’s full statement of the relief requested is provided, *infra*, at §§ VII and VIII.

IV. PERSON OF ORDINARY SKILL IN THE ART (“POSA”)

A POSA is presumed to be aware of all pertinent art. The POSA possesses the “understandings and knowledge reflected in the prior art” and thinks along conventional wisdom. *See Abbott Labs. v. Andrx Pharm., Inc.*, 452 F.3d 1331, 1336 (Fed. Cir. 2006). Because the ’927 patent relates to the basic material science of battery separators, the level of skill in the art is moderately high.

A person of ordinary skill in the relevant art would typically hold an advanced degree in chemistry, material science, and/or a related discipline, and have at least two years of experience with designing and/or fabricating battery separators or have an equivalent level of education, training, and experience. EX1003, ¶48. Of course, additional years of experience might compensate for fewer years of education in the relevant field, and vice versa.

V. BACKGROUND OF THE ART

A. Battery Components

All batteries have a cathode and an anode, with a separator between them. EX1003,¶50. It has long been known that batteries have a risk of explosion or other danger if the physical housing of the battery is punctured and the separator is broken, especially where the puncture introduces a conductive object that shorts the circuit between the cathode and anode. For that reason, designers of battery separators have been focused on the deformation of separators to protect against punctures for years. *Id.*

A common battery separator architecture includes a porous substrate like a polymer film, and a coating or resin layer. EX1003,¶51. The coating is typically a porous layer that includes a binder (adhesive) and a filler (organic or inorganic particles). In a battery separator, the binder (adhesive) acts as a glue to hold the various components of the separator together, ensuring its structural integrity, while the filler is added to modify specific properties like porosity, wettability, and thermal stability, often by providing additional surface area for the electrolyte to interact with within the separator matrix. *Id.*

B. Separator Parameters and Relationships

POSAs have studied the deformation of separators to protect against punctures for years. In particular, POSAs used tensile testing to determine elastic strain (stretching that a material rebounds and recovers from) and plastic strain

(stretching that does not rebound). EX1003, ¶52. The '927 patent coins the term “absolute plastic deformation rate” to describe the amount of plastic strain. The inventors simply stretched an object to breaking and measured it post-breakage. The post-breakage length does not include elastic strain, which rebounds after breaking. What remains is therefore the portion of the elongation that does not rebound, or plastic strain. “Absolute plastic deformation rate” is just: (1) total strain (i.e., elongation at break), minus (2) elastic strain. The prior art discloses (1) total strain and (2) data from which one can calculate and subtract out elastic strain. *Id.*

For example, Nishikawa and Chen include tables with data that can be used to calculate the claimed absolute and relative separator plastic deformation rates:

Nishikawa

TABLE 1

	Porous Substrate						Adhesive Porous Layer				
	Thickness	Standard Deviation/ Mean of	Elongation [%]	Puncture Resistance	Tensile Strength [N/cm]	Young's Modulus [GPa]	Adhesive Resin		Filler Mass	Areal Weight	Standard Deviation/ Mean of Areal
	[μm]	Thickness	MD/TD	[g]	MD/TD	MD/TD	Kind	Mw	Ratio	[g/m ²]	Weight
Example 1	9	0.01	82/113	411	20/14	2.4/1.3	PVDF	1,950,000	0.01	2.3	0.13
Example 2	9	0.01	82/113	411	20/14	2.4/1.3	PVDF	1,950,000	0.03	2.4	0.28
Example 3	9	0.01	82/113	411	20/14	2.4/1.3	PVDF	1,950,000	0.05	2.4	0.20
Example 4	9	0.03	81/110	405	21/14	2.4/1.3	PVDF	1,950,000	0.01	2.3	0.25
Example 5	9	0.02	100/150	420	22/16	2.3/1.2	PVDF	1,950,000	0.5	2.5	0.30
Example 6	9	0.02	150/115	380	19/13	2.0/1.0	PVDF	1,950,000	0.5	2.4	0.29
Example 7	9	0.01	82/113	411	20/14	2.4/1.3	PVDF	600,000	0.01	2.3	0.28
Example 8	9	0.01	82/113	411	20/14	2.4/1.3	PVDF	3,000,000	0.01	2.3	0.29
Comparative Example 1	9	0.01	82/113	411	20/14	2.4/1.3	PVDF	1,950,000	0.10	2.4	0.40
Comparative Example 2	12	0.05	210/250	305	19/15	1.1/0.7	PVDF	1,950,000	0.01	2.3	0.39
Comparative Example 3	9	0.03	45/120	320	22/10	3.1/0.9	PVDF	1,950,000	0.01	2.3	0.35
Comparative Example 4	30	0.04	70/100	850	60/44	2.2/1.2	PVDF	1,950,000	0.01	2.3	0.41
Comparative Example 5	12	0.03	110/6	190	26/2	3.0/0.5	PVDF	1,950,000	0.01	2.3	0.33

Separator
EX1004, Table 1.

Chen

Separator	Direction	Measured modulus ^a (MPa)	Tensile strength (MPa)	Strain that non-linearity occurred (%)	Strain at break (%)
2325	MD	935 ± 43	175.2 ± 9.1	0.79	155.9
	TD	510 ± 24	14.7 ± 1.9	0.61	164.9
2400	MD	873 ± 37	146.5 ± 7.4	0.85	164.3
	TD	502 ± 28	13.4 ± 2.2	0.76	164.2
V20CFD	MD	675 ± 25	65.3 ± 5.3	0.68	333.2
	TD	781 ± 39	72.6 ± 6.7	0.72	241.5
V20EHD	MD	696 ± 48	102.7 ± 7.8	0.65	547.7
	TD	823 ± 52	127.8 ± 9.1	0.87	453.2
Teijin	MD	733 ± 41	120.6 ± 9.6	0.63	142.2
	TD	622 ± 36	90.1 ± 8.5	0.54	134.9

^a The Young's modulus was calculated from the slope of the linear stress-strain curve in the strain range of 0–0.5%.

EX1005, 14909 (Table 2).

1. Strain and Tensile Strength

Strain is how a material responds to a force per unit area (stress). Stress is defined as: $\sigma = \frac{F}{A}$, where F is the force applied to the separator and A is the original cross sectional area of the material. EX1003, ¶52. Strain reflects a change in length in response to the stress and is defined as: $\varepsilon = \frac{L-L_0}{L_0}$, where L is the measured length of the material and L₀ is the original length. Percent strain is measured by the following standard equation: $\varepsilon = \frac{L-L_0}{L_0} \times 100\%$. EX1005, 14908-11. When a force is applied, elastic deformation happens first. With continued force, plastic deformation starts to occur. *Id.*

The limit of the elastic and plastic deformation (together the “elongation”) is the breaking point (or fracture point). The maximum stress a material can withstand before breaking is the ultimate tensile stress (strength). The transition

point between the elastic and plastic deformation of the material is denoted the yield strength, and this transition point is called the yield point. *Id.*

2. Young's Modulus

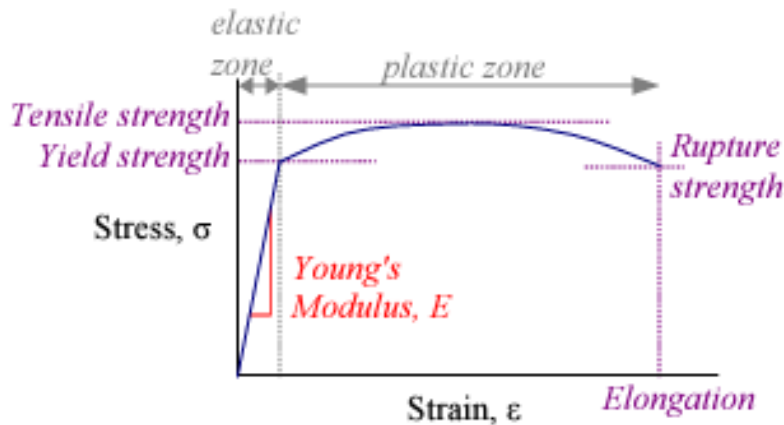
The Young's Modulus (also called the elastic modulus) is the slope of the linear portion of the stress-strain curve. EX1005, 14908-11. Examples of stress-strain curves are depicted in Sections V.C. and V.D. below. This linear portion of the stress-strain curve is the elastic deformation zone of the material.

3. Elastic Strain

Most elastic strain in a polymer material occurs early in the stress strain curves (i.e., up to a yield stress). After the yield stress, plastic deformation of the material starts to occur. EX1017, 42. The yield stress can be measured as the maximum stress at a yield peak in the stress-strain curve. *Id.* In materials without a prominent yield peak, the yield stress can be determined by calculating a 0.2% offset. EX1019, 8; EX1018, 61, EX1021, 87. The .02% offset method is known in the art as a broadly applicable methodology for approximating yield stress based on the innate properties of polymers. EX1019, 8; EX1018, 61, EX1021, 87.

Young's modulus and breaking stress can also be used to estimate the elastic strain of a material. EX1003, ¶¶60-62. If the breaking strength and strain at break are known, an "elastic line" with a slope equal to Young's modulus can be traced backward from the point of ultimate tensile strength and the strain axis, illustrated

below. *Id.* This is analogous to the spring back experienced when force is no longer applied to the material. The elastic strain (E_E) is equal to the strain between the intersection of the elastic line and the strain axis and the strain at which the breaking stress occurs.



EX1020, 18.

Then, elastic strain can be calculated mathematically using the standard slope equation: $\Delta y / \Delta x = m$ where Δy is the breaking stress, Δx is the elastic strain, and m is Young's modulus. EX1003, ¶¶59-60. Solving for elastic strain gives you Elastic Strain = breaking stress/Young's Modulus. This equation can also be used to estimate elastic stain when a stress-stain curve is unavailable, but the breaking strength and Young's modulus are known. *Id.*

4. Plastic Strain

The strain at break represents the total deformation of the material, which is the sum of the elastic strain and plastic strain. EX1003, ¶62. The elastic strain is multiplied by 100% to convert to percent strain, and then subtracted from percent

strain at break to calculate plastic strain or absolute plastic deformation rate. To find the relative plastic strain, a POSA divides the plastic strain by the strain at break, and multiplies by 100%. *Id.* This is referred to as the “relative plastic deformation rate” in the ’927 patent:

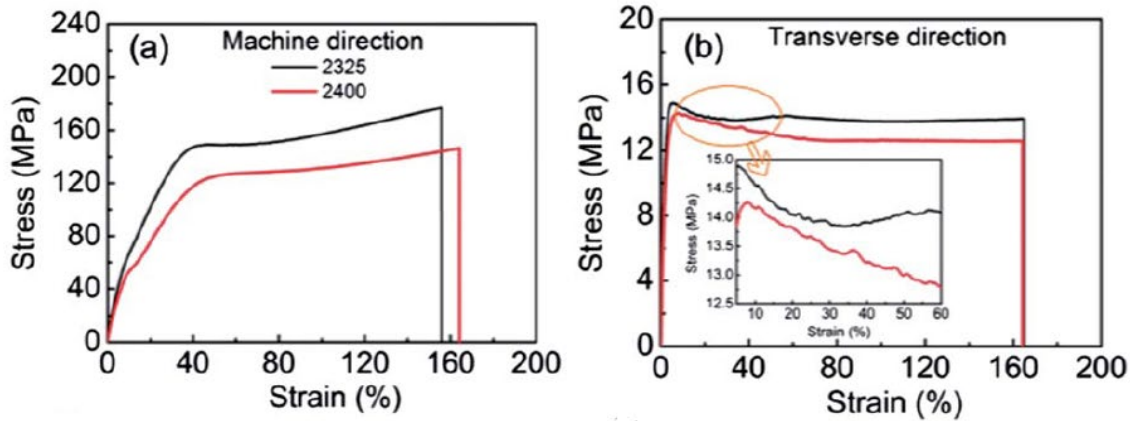
$$\text{Relative Plastic Strain} = \text{Plastic Strain} / \text{Strain at Break} * 100\%$$

Plotting stress-strain curves, measuring yield strength, determining plastic and elastic deformation, and calculating the Young’s modulus is how materials scientists have analyzed polymer films for decades. *See generally*, EX1005.

C. Chen

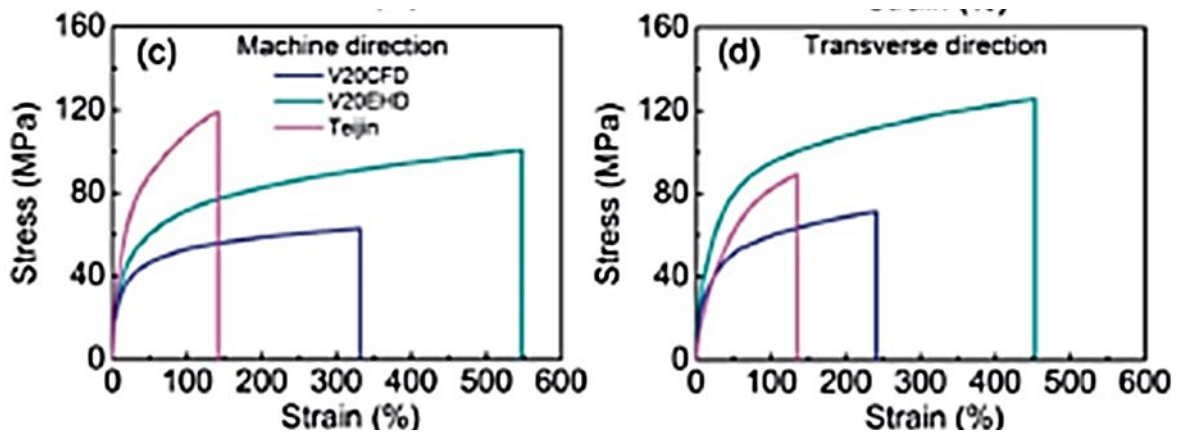
Chen is an article that performs tensile tests on five commercially available battery separators in two orthogonal directions (called the machine and transverse directions or MD and TD). EX1005, 14906-07. Chen reports the stress-strain curves and analyzes the material deformation (i.e., elongation) of the separator. EX1005, 14908. Chen compares the results of different kinds of separators made used different manufacturing processes (i.e. coated and uncoated separators, wet and dry processes). EX1005, 14908-11.

Figure 1 shows stress-strain curves for the dry-process separators in the MD and TD. EX1005, FIG. 3, 14908. Both curves show early yielding (only a small amount of elastic strain) followed by a sustained period of plastic behavior.



EX1005, FIG. 3 (excerpted).

Figure 2 shows stress-strain curves for wet-process separators in MD and TD. EX1005, FIG. 3, 14908. These are also dominated by plastic strain with even less elastic deformation. EX1003, ¶¶53-56. Accordingly, all of the battery separators tested exhibit high rates of absolute and relative plastic deformation. EX1005, FIG. 3, 14908.



EX1005, FIG. 3 (excerpted).

Chen also gives Young's modulus, tensile strength, and strain at break shown in the table below:

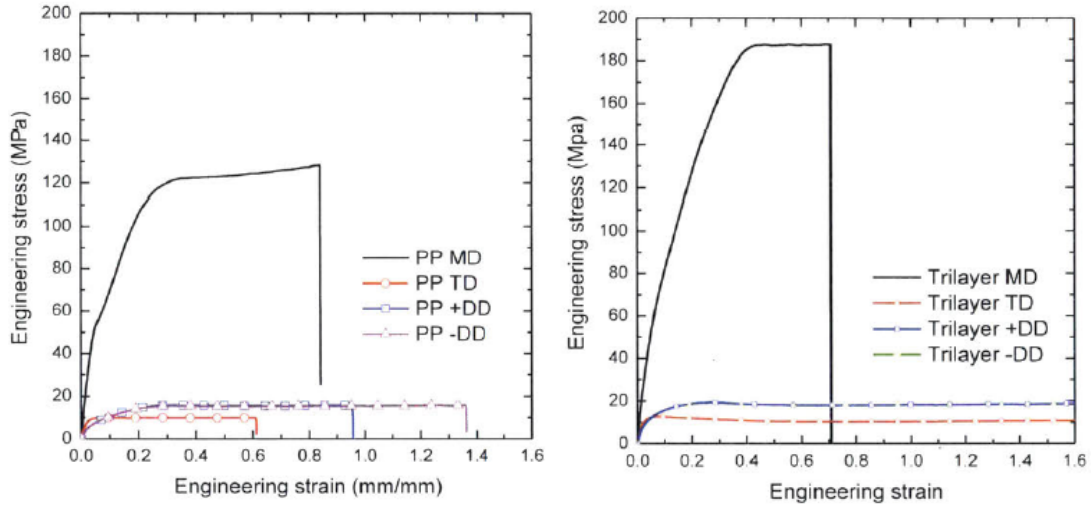
Separator	Direction	Measured modulus ^a (MPa)	Tensile strength (MPa)	Strain that non-linearity occurred (%)	Strain at break (%)
2325	MD	935 ± 43	175.2 ± 9.1	0.79	155.9
	TD	510 ± 24	14.7 ± 1.9	0.61	164.9
2400	MD	873 ± 37	146.5 ± 7.4	0.85	164.3
	TD	502 ± 28	13.4 ± 2.2	0.76	164.2
V20CFD	MD	675 ± 25	65.3 ± 5.3	0.68	333.2
	TD	781 ± 39	72.6 ± 6.7	0.72	241.5
V20EHD	MD	696 ± 48	102.7 ± 7.8	0.65	547.7
	TD	823 ± 52	127.8 ± 9.1	0.87	453.2
Teijin	MD	733 ± 41	120.6 ± 9.6	0.63	142.2
	TD	622 ± 36	90.1 ± 8.5	0.54	134.9

^a The Young's modulus was calculated from the slope of the linear stress-strain curve in the strain range of 0–0.5%.

EX1005, 14909 (Table 2).

D. Zhang Thesis

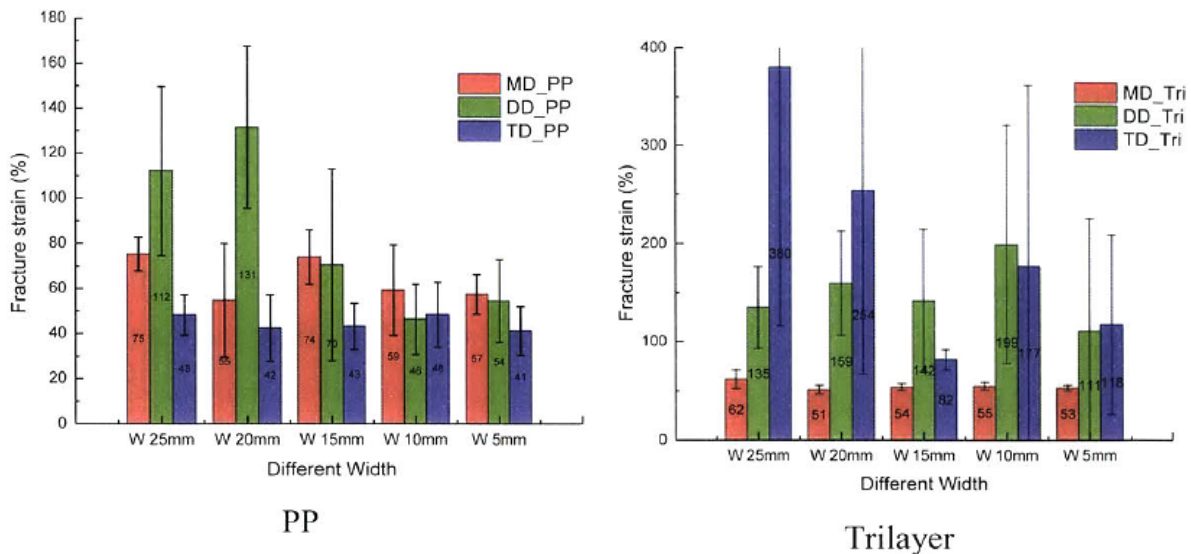
The Zhang Thesis teaches tensile testing for polymer-based battery separators. EX1007 (testing the mechanical properties of commercially available battery separators). Zhang's tensile tests were performed on various geometries of test strips using the ASTM D882 standard—a well-accepted methodology in the art. EX1007, 67. The Zhang Thesis generates and compares the stress-strain curves for a polypropylene dry-process separator (PP) and a tri-layer dry-process separator (trilayer) (reproduced below). EX1007, FIG. 3-1(b)-(c).



EX1007, FIG. 3-1(b)-(c).

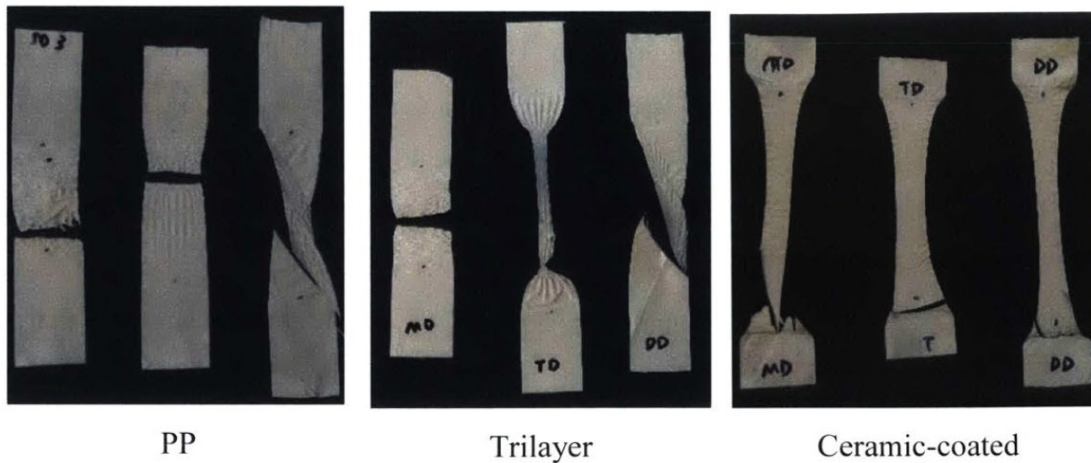
MD refers to machine direction, TD to transverse direction, and DD to diagonal direction (about 45 degrees from TD and MD). Zhang Thesis plots how to obtain different percent strains at fracture by changing the widths of the materials.

EX1007, 70, FIG. 3-2(a).



EX1007, 70, FIG. 3-2(a).

These stress-strain curves were generated by stretching a sample of the battery separator to the breaking point and measuring the strain. EX1003, ¶¶64-71. Post-test pictures show the plastic deformation in photographs of the separators that have been stretched to break, docked, and flattened:



EX1007, FIG. 3-2(b) (excerpted).

These separators exhibit a large degree of absolute and relative plastic deformation based on the stress-strain curves and fracture strains. EX1003, ¶¶64-71. That measured property matches the visible results. Accordingly, battery separators having a large absolute and relative plastic deformation rate, as determined when stretched until breaking, were well known in the art.

VI. OVERVIEW OF THE '927 PATENT

The '927 patent has apparatus claims that recite standard battery components: an anode, a cathode, and a separator comprising a porous substrate (polymer film) and a porous layer (binder and inorganic filler). EX1003, ¶72. The

claims then recite innate parameters of the components, but with unorthodox terminology. Specifically, the claims recite an “absolute plastic deformation rate” or a “relative plastic deformation rate.” These phrases are not typically used in this art. EX1003, ¶73. Nonetheless, a POSA reading the Specification would understand these terms to refer to the porous substrate’s total plastic strain, and plastic strain relative to elastic strain, expressed as a percentage.² *Id.*

A. The Alleged Invention

Claim 1, the sole independent claim, recites that the porous substrate has an absolute plastic deformation rate in a certain percentage range, where the plastic deformation rate is measured according to a recited protocol. EX1003, ¶73. The dependent claims progressively narrow the absolute plastic deformation rate range, add a *relative* plastic deformation rate range, or recite large Markush groups listing common materials for use in the battery separator components. *Id.*

Importantly, the plastic deformation rate limitations are not method steps, nor do the claims recite product-by-process limitations. Nothing about the plastic deformation rates or the way they are measured recites an action that must be

² While Petitioner uses the claim terms as PO has implicitly defined them throughout, Petitioner does not acquiesce to these definitions, which may be challenged in other forums.

performed, namely they do not add patentability to the claim. Rather, the plastic deformation rates as recited merely identify an innate physical property of the polymer film that is used as the porous substrate. EX1003, ¶74. This property is well-known in the art, and is typically referred to as plastic strain to failure or plastic strain to break. EX1003, ¶62.

PO claims to have discovered that the plastic deformation rate of the substrate polymer layer of a battery separator influences whether the resulting separator will pass a given nail-penetration test. EX1001, Table 1. The tests performed and described in the Specification involved primarily polyethylene films coated with a polyacrylonitrile binder and alumina (Al_2O_3). EX1003, ¶75. For example, when the plastic deformation rate of the polymer film is within the claimed range, decreasing porosity or increasing thickness allegedly improves the nail test passage rate. EX1001, 22:19-23:5. Conversely, for polymer films that do not fall within the given plastic deformation range, the patent reports that no amount of change to the porosity or thickness will improve the nail-test passage rate. EX1001, Table 1.

B. The '927 Patent Global Family Prosecution History

The '927 patent was filed as Application No. 16/202,346 on November 28, 2018. It claims the benefit of Chinese application CN 2018/10640157. The claims of the related Chinese patent are very similar to the '927 patent, except that in

China PO was forced to add limitations to the independent claim's relative plastic deformation rate to overcome clarity, support, and prior-art rejections.

EX1003, ¶76.

In the first Office Action, the Chinese Examiner found the claims lacked an inventive step over CN105449140A. EX1008, 0006-07. This reference disclosed a separator and a lithium-ion secondary battery, and specifically disclosed the following technical features (¶¶[0013]-[0026], [0147], and [0155]-[0157]):

- a porous substrate selected from at least one of polyolefin, polyimide, polyurethane, and polyisocyanate;
- the surface of the separator may be coated with an inorganic particle coating and/or an organic particle coating (equivalent to “a porous layer, and the porous layer is disposed on a surface of the porous substrate and comprises inorganic particles”);
- the separator has puncture resistance and an elongation at break of 150%-900% in a transverse direction an elongation at break of 55%-600% in a longitudinal direction.

EX1008, 0006. The Examiner also observed that the prior art disclosed that when the battery is pierced by a nail or other needle-like foreign bodies, a porous substrate with good ductility is used to extend with the foreign body and wrap the foreign body by means of its good plastic deformation capacity, thus improving the

safety of the battery. EX1003, ¶¶77-79. On this basis, to select a suitable porous substrate, a POSA readily conceived of evaluating the plastic deformation capacity of the porous substrate via such an index of relative plastic deformation rate and determining the suitable ranges of the relative plastic deformation rate in the first and/or second direction through limited number of tests. EX1008, 0006-07.

The Examiner found that the reference did not disclose that the porous layer further comprises a binder, but observed that fixing inorganic particles on a porous substrate with a binder is a conventional technical means in the art. EX1008, 0008. The Examiner found the prior art disclosed the dependent claims. EX1008, 0006-08.

PO did not dispute the Examiner's findings. Instead, PO argued that the claims recite the absolute plastic deformation rate of the *porous substrate*, rather than the separator as a whole, which distinguished the claimed range from the disclosure of the reference. EX1003, ¶¶80-82. PO also argued that the absolute plastic deformation rate was measured differently than the properties taught by the reference. EX1008, 0012-13.

In response, the Examiner observed that the method of calculating the absolute plastic deformation rate was not recited in the claims as they were then presented, and therefore the claims lacked clarity—the Chinese version of an indefiniteness rejection. EX1008, 0017. The Examiner also rejected the claims as

lacking support (the Chinese version of a written-description rejection) because the application does not explain how to achieve the desired plastic deformation rate—only how to measure it. *Id.*

PO, in response to the clarity rejection, amended the claims to add the same equation and absolute plastic deformation measurement that appears in '927 patent claim 1. EX1008, 0022. In response to the lack of support rejection, PO argued: “it should be known to those skilled in the art that the plastic deformation rate of the porous substrate is mainly affected by the stretching conditions in the process of preparation.” EX1008, 0024. PO said, “it would be known to those skilled in the art that for porous substrates with different materials and molecular weight, their desired absolute plastic deformation rates can be obtained by changing a stretching ratio.” EX1008, 0024. In other words, PO represented that it was well known in the art how to achieve the plastic deformation rates recited in the claims.

These amendments and arguments overcame the clarity and support rejections, but did not overcome the prior-art rejection. EX1003, ¶¶80-83. The Examiner still found that the claimed absolute plastic deformation rate was inferable from the reference. EX1008, 0028-29.

Once again, PO did not contest the Examiner’s findings. It instead amended claim 1 to recite the relative plastic deformation rate disclosed in '927 patent

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claims 4 and 5. EX1008, 0036-40. The Examiner did not explain why this amendment led to allowance, but issued the claims as amended. EX1008, 0041-42.

Meanwhile, the USPTO Examiner rejected the claims over U.S. Patent No. 5,746,916 to Kamo. The Examiner found that Kamo disclosed all the limitations of the separator, i.e., the porous substrate, porous layer, composition components, and physical properties (including the absolute and relative plastic deformation rates). Specifically, the Examiner cited Kamo's disclosure of the stretching ratio in the method of manufacture as disclosing the claimed plastic deformation rates, consistent with PO's statement during the Chinese prosecution. *Compare* EX1002, 0054-57 *with* EX1008, 0024 (“[I]t would be known to those skilled in the art that . . . desired absolute plastic deformation rates can be obtained by changing a stretching ratio.”). In other words, even though Kamo did not expressly disclose absolute or relative plastic deformation rates, and did not disclose the method of measurement recited in the claim, the Examiner rightly recognized that it nonetheless disclosed the claimed plastic deformation by disclosing the stretching ratio from which that plastic deformation could be derived. EX1003, ¶¶85-86.

The Examiner alleged that Kamo did not disclose the use of the resulting membrane as a battery separator. Instead, it was disclosed as a separator for medical devices, food industries, or water or air purification. The Examiner allowed the claims on that basis. EX1002, 0056-57. The Examiner did not consider

any of the prior art cited in this Petition that discloses all the limitations of the claimed separator *specifically for use as a battery separator*.

VII. CLAIM CONSTRUCTION

In an *inter partes* review, all claim terms must be given their ordinary and customary meaning as understood by a POSA at the time of the invention, in light of the specification and the prosecution history. 35 U.S.C. § 282(b); 37 C.F.R. § 42.100(b). For the purposes of this Petition, Petitioner submits that all claim terms should receive their plain and ordinary meaning in the context of the Specification, with the exception of terms that are expressly defined by equations.³ EX1003, ¶38. Specifically, the term “absolute plastic deformation rate” is defined as the property ϵ_1 expressed by the equation $(L_2 - L_0)/L_0 \times 100\%$. EX1001, 4:47-54. The term “relative plastic deformation rate” is defined as the property ϵ_2 expressed by the equation $(L_2 - L_0)/(L_1 - L_0) \times 100\%$. *Id.*

These terms should be construed as extending to the physical properties they denote, even though those properties may also be expressed by other equations. The Specification observes that “[p]lastic deformation is a permanent deformation that does not bounce back.” EX1001, 4:27-28. This is consistent with the plain and

³ Petitioner reserves the right to challenge the validity of the claims under §112 or any other grounds it is legally permitted to raise in other proceedings and forums.

ordinary meaning of “plastic deformation,” a well-known property that can be measured and expressed (as an “absolute” or “relative” “rate” or percentage) using various well-known inputs. In any event, Petitioner submits that the prior art anticipates and renders obvious the challenged claims under any reasonable construction of these terms.

VIII. GROUND 1: CLAIMS 1-10 ARE ANTICIPATED BY NISHIKAWA

U.S. Publication No. 2015/0180002 to Nishikawa published on June 25, 2015. Nishikawa anticipates claims 1-10. For instance, Nishikawa Example 1 discloses a porous separator for a lithium ion battery that discloses the features of claims 1-10. EX1003, ¶87.

A. 1.P: An electrochemical device, comprising:

To the extent the preamble is limiting, Nishikawa discloses an electrochemical device. Nishikawa discloses “[a] non-aqueous electrolyte battery.” EX1004, [0012]. A battery is an electro-chemical device—the same electro-chemical device recited in the body of the claims. EX1003, ¶88.

B. 1.1: a cathode; an anode; and a separator;

Nishikawa discloses, “A non-aqueous electrolyte battery including a positive electrode, a negative electrode, and the separator for a non-aqueous electrolyte battery of any one of <1> to <7> disposed between the positive electrode and the negative electrode.” EX1004, [0012]. A cathode is a positive electrode and an anode is a negative electrode. EX1003, ¶89.

C. 1.2: wherein, the separator comprises a porous substrate and a porous layer;

Nishikawa explains, “The separator for a non-aqueous electrolyte battery of the invention includes a porous substrate and an adhesive porous layer.” EX1004, [0016]; EX1003, ¶91. Nishikawa Example 1 discloses a separator comprising a polyethylene porous substrate that is coated on both sides with a porous layer, specifically a vinylidene fluoride/hexafluoropropylene copolymer (binder) and magnesium hydroxide (inorganic particles). EX1004, [0147]-[0150]; EX1003, ¶90. The porous substrate and porous layer of Nishikawa play the same roles in Nishikawa’s separator that those structures play in the claimed separator, confirming that these are the same disclosed structures. EX1003, ¶92; EX1004, [0009]-[0010], [0012].

D. 1.3: wherein the porous layer is disposed on a surface of the porous substrate and comprises inorganic particles and a binder;

Nishikawa discloses, “[t]he adhesive porous layer is provided on one side or both sides of the porous substrate.” EX1004, [0016]. The adhesive porous layer contains an adhesive resin and a filler. EX1004, [0086]. Nishikawa further explains that the filler that may be an inorganic substance. EX1004, [0084]; EX1003, ¶94. “Examples of inorganic fillers include metal oxides such as alumina and metal hydroxides such as magnesium hydroxide.” EX1004, [0085]. Nishikawa’s

adhesive resin is a binder. EX1003, ¶93. The inorganic filler is the claimed inorganic particles. *Id.*

The purpose of the adhesive resin is to adhere (or bind) to the porous substrate. EX1004, [0075]. The sides of Nishikawa's porous substrate are surfaces onto which the porous layer is disposed. The adhesive porous layer (adhesive resin and filler) of Example 1 is deposited onto both sides of Nishikawa's polyethylene porous substrate. EX1004, [0147]-[0150]. Nishikawa thus discloses a porous layer disposed on a surface of the porous substrate and comprises inorganic particles and a binder. EX1003, ¶94.

- E. 1.4: the porous substrate has an absolute plastic deformation rate in a first direction ranging from about 40% to about 1800%, and wherein the absolute plastic deformation rate is calculated according to an equation $(L2-L0)/L0 \times 100\%$, where L0 refers to a length of the porous substrate before stretching and L2 refers to a length of the porous substrate after the porous substrate is stretched to breakage and docked along the fracture caused by the breakage and flattened.**

Nishikawa discloses an “absolute plastic deformation rate” as defined in the patent, and within the claimed range, both expressly and inherently. EX1004, Table 1; EX1003, ¶95.

1. Nishikawa Expressly:

The claims define “absolute plastic deformation” (“APD”) in terms of the difference between the length of separator before and after it is stretched to its breaking point (i.e., $L2-L0$). It reflects the amount a separator is deformed

permanently, and will not rebound when the force of a stress test is removed.

EX1003,¶69. This property can be estimated from data disclosed in Nishikawa, specifically the strain at break (elongation) and the plastic strain. EX1003,¶¶95-98. The strain at break represents the total deformation of the material: the sum of both elastic strain and plastic strain. *Id.*

Calculating the absolute plastic deformation is a simple matter of subtracting the elastic strain from the strain at break:

$$\text{APD} = \text{Strain at break (Total elongation)} - \text{elastic strain (Rebound)}$$

Importantly, claim 1's equation does not reflect a new discovery or new physical property of materials. EX1003,¶98. It is the standard way of expressing any change in a component of a value (here, plastic deformation) isolated from that value (here, total deformation) as a percentage.⁴ By specifying how the values used in the equation were obtained (stretching to break, docking, and measuring), the claim merely clarifies what absolute plastic deformation represents. *See Teva Pharmaceuticals USA Inc. v. Sandoz Inc.*, 789 F.3d 1335 (Fed. Cir. 2015).

⁴ For instance, the equation in claim 1 can be used to express the sale price of shoes, where L0 is the original price (e.g., \$50) and L2 is the sale price (e.g., \$40). $(40-50)/50 \times 100\% = -20\%$, i.e., the shoes are 20% off.

The total elongation of a material ($L_1 - L_0$) in combination with its tensile strength and Young's modulus (a proxy for $L_1 - L_2$ as those lengths are defined in the '927 patent) are inputs from which a POSA could derive the claimed absolute plastic deformation rate ($((L_2 - L_0)/L_0 \times 100\%)$). EX1003, ¶97. Even though it does not use the words “plastic deformation rate,” Nishikawa discloses numeric values that describe this physical property in the same way that a reference discloses, for example, the density of an object by providing numeric values for its mass and volume.⁵ *Id.*

As another analogy, consider a claim that recites Composition X, wherein the melting point of composition X is 20-30°C as measured by a mercury

⁵ It is not merely that the density of an object is inherent when the object has a particular mass and volume. Because mass, volume, and density have a defined mathematical relationship, a reference *discloses* a numeric density by disclosing mass and volume—it is simply using different metrics to convey the same information. In other words, density is inherent in the object itself. Density is disclosed by measuring it directly, or by disclosing mass and volume. Similarly here, the plastic deformation rate of a material is inherent to that material. It can be disclosed by measuring it directly, or by disclosing other metrics from which plastic deformation can be calculated.

thermometer. The claim is a composition claim, the melting point is a recited property, and the specified method of measurement merely clarifies what the temperature denotes—it does not add a method step. A prior-art reference that describes Composition X melting at 77°F as measured by an alcohol thermometer anticipates the claim.⁶ It anticipates the claim even though it expresses the temperature using a different tool and scale, because a POSA would know how to convert from Fahrenheit to Celsius, and would understand the two scales to be nothing more than two ways of expressing the same information. EX1003,¶99.

The plastic deformation rate claimed here presents the same situation. EX1003,¶101. The claim recites a porous substrate with an absolute plastic

⁶ Of course, a POSA would know that a mercury thermometer is more accurate than an alcohol thermometer, and would understand that while 77°F equals 25°C, the temperature measured on an alcohol thermometer does not necessarily equal the temperature measured on a mercury thermometer. Nonetheless, where, as in this analogy, the claim recites a temperature range and the prior art discloses a value that is comfortably within that range (albeit by a less accurate measurement) the POSA would still understand the claim to be anticipated. The difference in accuracy of an alcohol thermometer is not enough to risk bringing the measured value outside the claimed range. EX1003,¶100.

deformation rate that falls within a large range. It provides a method by which that range can be measured (stretching to break, docking, flattening, measuring, and calculating) merely to clarify what is meant by “absolute plastic deformation rate” and the inputs to the recited equation. *Id.* Nishikawa also discloses porous substrates that have absolute plastic deformation rates in this range, even though Nishikawa uses a different means of measuring that property (measuring stress at breaking, tensile strength, and Young’s modulus), and expresses it in different terms. EX1003, ¶102. A POSA would nonetheless understand the porous substrates of Nishikawa to necessarily⁷ have the claimed plastic deformation property. EX1003, ¶103.

In *Teva*, the Federal Circuit explained that a numerical range recited for the “molecular weight” of a composition was indefinite because measuring “molecular

⁷ As in the temperature analogy, if the values disclosed in Nishikawa are comfortably within the claimed range, a POSA would know that differences in the method of measurement are of no consequence. The absolute plastic deformation rate of the substrates in Nishikawa (and Chen and Zhang as discussed in Grounds 2A/B and 3) are so comfortably within the claimed range that a POSA would understand them to *necessarily* disclose the claimed property despite the differences in how the values were obtained.

weight” according to “peak average,” “number average” or “weight average” could yield different numerical results. *Teva*, 789 F.3d at 1338. Identifying the method of measurement would provide the needed context for the numeric range. It would not introduce a method step into the composition claims.

Here, providing the equation and variables for plastic deformation rate merely identifies one way of expressing plastic deformation among other possible ways. Indeed, this is the exact issue the Chinese Examiner identified in prosecution: without explaining how the plastic deformation rate was measured, it was not clear what the percentage numbers actually represented. EX1008, 0024. This clarification does not impart any patentable feature into the material, as the measurement is not a method step that must be performed. It is no different than specifying how molecular weight is calculated for a claim that recites a material having a particular molecular weight range. *Teva*, 789 F.3d at 1338.

Nishikawa Table 1 gives measured values of Young’s modulus, tensile strength, and elongation for multiple porous substrates that can be used to approximate this value. EX1003, ¶104. Elastic strain can be approximated as Stress at break / Young’s modulus * 100%. The stress at break is equal to the tensile stress. EX1004, [0133].

TABLE 1

	Porous Substrate						Adhesive Porous Layer				
	Thickness	Standard Deviation/ Mean of	Elongation [%]	Puncture Resistance	Tensile Strength [N/cm]	Young's Modulus [GPa]	Adhesive Resin		Filler Mass	Areal Weight	Standard Deviation/ Mean of Areal
	[μm]	Thickness	MD/TD	[g]	MD/TD	MD/TD	Kind	Mw	Ratio	[g/m ²]	Weight
Example 1	9	0.01	82/113	411	20/14	2.4/1.3	PVDF	1,950,000	0.01	2.3	0.13
Example 2	9	0.01	82/113	411	20/14	2.4/1.3	PVDF	1,950,000	0.03	2.4	0.28
Example 3	9	0.01	82/113	411	20/14	2.4/1.3	PVDF	1,950,000	0.05	2.4	0.20
Example 4	9	0.03	81/110	405	21/14	2.4/1.3	PVDF	1,950,000	0.01	2.3	0.25
Example 5	9	0.02	100/150	420	22/16	2.3/1.2	PVDF	1,950,000	0.5	2.5	0.30
Example 6	9	0.02	150/115	380	19/13	2.0/1.0	PVDF	1,950,000	0.5	2.4	0.29
Example 7	9	0.01	82/113	411	20/14	2.4/1.3	PVDF	600,000	0.01	2.3	0.28
Example 8	9	0.01	82/113	411	20/14	2.4/1.3	PVDF	3,000,000	0.01	2.3	0.29
Comparative Example 1	9	0.01	82/113	411	20/14	2.4/1.3	PVDF	1,950,000	0.10	2.4	0.40
Comparative Example 2	12	0.05	210/250	305	19/15	1.1/0.7	PVDF	1,950,000	0.01	2.3	0.39
Comparative Example 3	9	0.03	45/120	320	22/10	3.1/0.9	PVDF	1,950,000	0.01	2.3	0.35
Comparative Example 4	30	0.04	70/100	850	60/44	2.2/1.2	PVDF	1,950,000	0.01	2.3	0.41
Comparative Example 5	12	0.03	110/6	190	26/2	3.0/0.5	PVDF	1,950,000	0.01	2.3	0.33

Separator

EX1004, Table 1.

As shown in Example 1, the tensile strength in the MD and TD are 20 and 14 N/cm respectively. Here, tensile strength is given in units of force/unit width. To convert to force/unit area, the reported tensile strength is divided by the thickness of the substrate, which is 9 μm or 9 * 10⁻⁴ cm. EX1003, ¶¶106-107. Dividing the tensile strengths of Nishikawa's Table 1 by the substrate thickness and converting to GPa gives:

$$\begin{aligned}
 \text{MD} &= \left(\frac{20 \frac{\text{N}}{\text{cm}}}{9 \times 10^{-4} \text{ cm}} \right) \left(\frac{10^4 \text{ cm}^2}{\text{m}^2} \right) = 2.22 * \frac{10^8 \text{ N}}{\text{m}^2} = 2.22 * 10^8 \text{ Pa} = 0.222 \text{ GPa} \\
 \text{TD} &= \left(\frac{14 \frac{\text{N}}{\text{cm}}}{9 \times 10^{-4} \text{ cm}} \right) \left(\frac{10^4 \text{ cm}^2}{\text{m}^2} \right) = 1.56 * \frac{10^8 \text{ N}}{\text{m}^2} = 1.56 * 10^8 \text{ Pa} = 0.156 \text{ GPa}
 \end{aligned}$$

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Elastic strain for Example 1 MD can be approximated as follows: elastic strain = 0.222 GPa (breaking strength) / 2.4 GPa (Young's Modulus) *100% = 9.25%. EX1003, ¶107. The elongation at break is 82%. Thus, the APD is approximated as follows: APD = 82% (strain at break) - 9.25% (elastic strain) = 72.75%. *Id.* Using the same method, it can be approximated that in the TD, the absolute plastic deformation is 101%. EX1003, ¶108.

Alternatively, plastic strain can be approximated using the .2% offset method. EX1003, ¶¶59, 106, 109; EX1018, 61; EX1019, 8; EX1021 87. Values associated with these calculations are summarized below:

	Tensile strength	Young's Modulus	Elongation at break	Elastic strain	Plastic strain
MD	0.222 GPa	2.4 GPa	82%	9.25-9.45%	72.55-72.75%
TD	0.156 GPa	1.3 GPa	113%	12-12.2%	100.8-101%

EX1003, ¶110. These plastic-strain values, i.e., “absolute plastic deformation rate[s]” both fall within the claimed range for the “first direction” recited in claim element 1.4. EX1003, ¶111.

2. Nishikawa Inherently

Even without performing the calculations, a POSA would understand the plastic deformation rate of Nishikawa's porous substrate to be within the claimed range. EX1003, ¶112. As Nishikawa prefers, “the material forming the porous substrate is a thermoplastic resin.” EX1004, [0037]. Thermoplastic resins exhibit a high degree of plastic deformation. EX1003, ¶112. It would be well within the

knowledge and skill of a POSA that the polymers of Nishikawa, given their various properties as reported, would necessarily have absolute plastic deformation rates over 40%. EX1003,¶113. Indeed, that is why these polymers are used for battery separators: they are known to be resistant to puncture and perform well in nail-penetration and similar tests. EX1003,¶50.

Moreover, Nishikawa discloses the method of manufacture for its separator. As the '927 patent applicant admitted, that would inform a POSA whether the plastic deformation rate was within the claimed range, because plastic deformation is a property imparted to the composition by its method of manufacture. EX1008, 24. A composition and its properties are inseparable: if the prior art teaches the composition, the properties of that composition as recited in the claim are necessarily present. *In re Spada*, 911 F.2d 705, 709 (Fed. Cir. 1990).

As such, the discovery of a previously unappreciated property of a prior art composition, or of a scientific explanation for the prior art's functioning, does not render the old composition patentably new to the discoverer. *Atlas Powder Co. v. Ireco, Inc.*, 190 F.3d 1342, 1347 (Fed. Cir. 1999); M.P.E.P. §2112(III). A prior-art disclosure may therefore *inherently* disclose a claim element even where a person of ordinary skill in the art would not have recognized that inherent element at the time of invention. *Schering Corp. v. Geneva Pharm.*, 339 F.3d 1373 (Fed. Cir. 2003). “[I]t is elementary that the mere recitation of a newly discovered function or

property, inherently possessed by things in the prior art, does not cause a claim drawn to those things to distinguish over the prior art.” *In re Swinehart*, 439 F.2d 210, 213-214 (C.C.P.A. 1971). This is true even if no prior art of record explicitly discusses the property. *In re Kubin*, 561 F.3d 1351 (Fed. Cir. 2009) (finding that where the patent explained that the claimed activity was an inherent property of the known composition, the prior art’s failure to mention this was irrelevant to a finding that the claim was obvious).

Accordingly, Nishikawa discloses all of the limitations of claim 1, expressly or inherently, and anticipates claim 1.

F. 2. The electrochemical device according to claim 1, wherein the porous substrate has an absolute plastic deformation rate in a second direction ranging from about 60% to about 1800%.

Nishikawa discloses dependent claim 2. Table 1 gives tensile strength, elongation, and Young’s modulus in a second direction, as it gives these values for both TD and MD. EX1003, ¶115.

As explained in Section V, the tensile strength, elongation, and Young’s modulus values indirectly disclose the absolute plastic deformation rate of the porous substrates in two directions. Both of the plastic deformation rate values disclosed in Nishikawa Example 1, calculated to be 72.55-72.75% and 100.8-101%, fall within the claimed numeric range for the second direction.

EX1003, ¶116. Nishikawa anticipates claim 2.

- G. 3. The electrochemical device according to claim 1, wherein the porous substrate has at least one of the following properties: an absolute plastic deformation rate in the first direction ranging from about 40% to about 1600%; and an absolute plastic deformation rate in the second direction ranging from about 70% to about 1600%.**

As discussed above for claims 1 and 2, Nishikawa's Table 1 discloses several examples of porous substrates that have plastic deformation rates in two directions that fall within the claimed ranges. EX1003, ¶117. Recall the plastic deformation rates for Example 1 are:

	Tensile strength	Young's Modulus	Elongation at break	Elastic strain	Plastic strain
MD	0.222 GPa	2.4 GPa	82%	9.25-9.45%	72.55-72.75%
TD	0.156 GPa	1.3 GPa	113%	12-12.2%	100.8-101%

Both MD and TD values fall within both claimed ranges. A POSA would at least consider the MD to satisfy the first direction and the TD to satisfy the second direction. EX1003, ¶118. Nishikawa anticipates claim 3.

- H. 4. The electrochemical device according to claim 1, wherein the porous substrate has at least one of the following properties: a relative plastic deformation rate in the first direction ranging from about 50% to about 100%; and a relative plastic deformation rate in the second direction ranging from about 60% to about 100%.**

Nishikawa does not provide numeric values for the percentage of elastic or plastic deformation, but it does provide elongation, tensile (breaking) strength, and Young's modulus. EX1008, Table 1. Using the calculated absolute plastic deformation rate for Nishikawa's porous substrate (shown above for claim 1), a

POSA could readily estimate the *relative* plastic deformation rate. EX1003, ¶¶119-120. This is done by dividing the plastic strain by the elongation at break and multiplying by 100%. EX1003, ¶121.

	Elongation at break	Absolute Plastic strain	Relative plastic strain
MD	82%	72.55-72.75%	88.5-88.7%
TD	113%	100.8-101%	89.2-89.4%

These values (88.5-88.7% and 89.2-89.4%) fall well within the numeric ranges recited (50-100% and 60-100%). The relative plastic deformation rates (MD and TD) of the porous substrate described in Nishikawa are therefore necessarily within the claimed ranges. EX1003, ¶122. Nishikawa anticipates claim 4.

- I. 5. The electrochemical device according to claim 4, wherein the porous substrate has at least one of the following properties: [1] a relative plastic deformation rate in the first direction ranging from about 65% to about 90%; and [2] a relative plastic deformation rate in the second direction ranging from about 75% to about 90%.**

As discussed above for claim 4, Nishikawa discloses porous substrates with a relative plastic deformation of 88.5-88.7% in the MD and 89.2-89.4% in the TD. EX1003, ¶123. These values fall within the numeric ranges recited in claim 5, specifically 65-90% in a first direction and 75-90% in a second direction. Additionally, the claim uses “about” to modify all of the numeric ranges which denotes up to $\pm 10\%$. EX1001, 3:33-45. Nishikawa thus necessarily discloses relative plastic deformation ranges for both the MD and TD (directions) as claimed. EX1003, ¶123. Nishikawa anticipates claim 5.

- J. 6. The electrochemical device according to claim 1, wherein the binder comprises at least one selected from the group consisting of a *vinylidene fluoride-hexafluoropropylene copolymer*, . . . , **polyimide**, . . . , a *styrene-butadiene copolymer*, and *polyvinylidene fluoride*.

Claim 6 depends from claim 1 and adds a large Markush group that provides a variety of options for the claimed binder. EX1003, ¶124. Nishikawa Example 1 (for which the plastic deformation calculations were performed above) uses *vinylidene fluoride-hexafluoropropylene copolymer*, the first ingredient listed in the Markush group above. EX1004, [0147]-[0150]. Nishikawa therefore anticipates claim 6.

Additionally, Nishikawa discloses, “the functional layer may be a porous layer made of a heat-resistant resin . . . and an inorganic filler . . . [including] heat-resist polymers selected from . . . **polyimide**.” EX1004, [0047]. A POSA would recognize that this resin is a binder, because it binds the inorganic particles to each other and indirectly to the substrate. EX1003, ¶125. Polyimide is one of the binders listed in the Markush group of claim 6 (in **red**). The inorganic filler is the claimed “inorganic particles.” *Id.*

Regarding the adhesive layer, Nishikawa discloses:

The adhesive resin contained in the adhesive porous layer is not particularly limited as long as it can adhere to electrodes. Preferred examples thereof include **polyvinylidene fluoride**, polyvinylidene fluoride copolymers, **styrene-butadiene copolymers**

EX1004, [0067]. A POSA would recognize that this adhesive resin is also a binder, because it binds the functional layer directly to the porous substrate.

EX1003, ¶¶126-127. Polyvinylidene fluoride and styrene-butadiene copolymers are listed in the Markush group of claim 6 (in blue).

Claim 6 makes clear that there can be multiple binders selected for the claimed separator, reciting, “the binder comprises at least one” of the listed materials. EX1003, ¶128. Nishikawa’s porous layer discloses claim 6 because it discloses several binders listed within the Markush group. *Id.* Nishikawa anticipates claim 6.

K. 7. The electrochemical device according to claim 1, wherein the inorganic particles comprise at least one selected from the group consisting of alumina, . . . , magnesium hydroxide, . . .

As discussed for claim 6, Nishikawa discloses an adhesive porous layer disposed on the surface of the substrate. EX1003, ¶129. Nishikawa discloses “[e]xamples of inorganic fillers include metal oxides such as alumina and metal hydroxides such as magnesium hydroxide.” EX1004, 0085.

Thus, Nishikawa discloses a porous layer including inorganic particles. EX1003, ¶130. Alumina (in purple) and magnesium hydroxide (in green) are both among the organic particles listed in the Markush group of claim 7. Magnesium hydroxide is the inorganic filler used in Nishikawa’s Example 1 (for which the

plastic deformation calculations were performed above). EX1004, [0147]-[0150].

Nishikawa anticipates claim 7.

- L. 8. The electrochemical device according to claim 1, wherein the porous substrate comprises a polymer film, a multilayer polymer film or a nonwoven fabric, . . . formed by any one or more of the following polymers: polyethylene, polypropylene, polyethylene terephthalate, . . ., polyamide, polycarbonate, polyimide, . . ., polyethersulfone, ...**

Nishikawa explains, “[a]s a porous substrate using a polyolefin, . . . a polyolefin microporous membrane containing polyethylene and polypropylene is preferable.” EX1004, [0040]-[0043]. Nishikawa further discloses, “[e]xamples of such substrates include microporous membranes, porous sheets made of a fibrous material, such as non-woven fabrics and paper-like sheets, and composite porous sheets including such a microporous membrane or porous sheet as well as one or more other porous layers laminated thereon.” EX1004, [0035].

“Examples of porous sheets made of a fibrous materials include...for example, polyesters such as polyethylene terephthalate; polyolefins such as polyethylene and polypropylene; and heat resistant polymers such as aromatic polyamide, polyimide, polyethersulfone.” EX1004, [0046]. Nishikawa thus discloses numerous examples of the porous substrate from the Markush group recited in claim 8. EX1003, ¶132.

Nishikawa's Example 1 porous substrate (for which the plastic deformation rates were calculated above) uses **polyethylene**. EX1004, [0147]-[0150]; EX1003, ¶131. Nishikawa anticipates claim 8.

M. 9. The ... device according to claim 1, wherein the porous substrate has a thickness ranging from about 1 to about 40 μm .

Nishikawa discloses multiple examples of porous substrates with a thickness between 1 and 40 microns. EX1003, ¶133. Examples 1-8 listed in Table 1, for instance, have thicknesses of 9 microns (μm). *Id.* Nishikawa anticipates claim 9.

N. 10. The electrochemical device according to claim 1, wherein the electrochemical device comprises lithium ion batteries.

Nishikawa discloses, "The nonaqueous electrolyte battery of the invention is suitable for a nonaqueous electrolyte secondary battery, particularly a *lithium ion* secondary battery." EX1004, [0107] (emphasis added). Nishikawa anticipates claim 10. EX1003, ¶134.

IX. GROUND 2A/2B: CLAIMS 1-10 ARE OBVIOUS IN VIEW OF NISHIKAWA/NISHIKAWA IN COMBINATION WITH CHEN

As discussed in Ground 1, Nishikawa (including, for instance, Nishikawa Example 1) explicitly or inherently discloses the claims. Nonetheless, to the extent the Board does not agree that Nishikawa explicitly or inherently discloses the absolute and/or plastic deformation rates of the porous substrate, then those limitations are at least obvious in view of Nishikawa (Ground 2A) or Nishikawa in combination with Chen (Ground 2B). EX1003, ¶135.

A. Ground 2A: Nishikawa's Example 1 satisfies every limitation of claims 1-10, including at least rendering obvious the recited plastic deformation rates.

Nishikawa discloses all of the components of the claimed lithium-ion battery and separator as discussed in Ground 1. EX1003, ¶136. To the extent the Board disagrees Nishikawa expressly or inherently discloses the claimed absolute and relative plastic deformation rates of the porous substrates, those rates are at least obvious in view of Nishikawa's disclosure. EX1003, ¶137. Specifically, Nishikawa discloses numeric values from which those rates can be estimated using well-known equations and physical relationships. *Id.* They are also obvious in view of Nishikawa's disclosure of the manufacture process and applications for its separator. EX1004, 24.

Absolute and relative plastic deformation rates—as those properties are defined in the patent—are inherent properties of the porous substrate. EX1003, ¶138. Inherent properties can render a claim obvious. *In re Kao*, 639 F.3d 1057 (Fed. Cir. 2011) (holding obvious a claimed effect that was an inherent property); *Santarus, Inc. v. Par Pharms., Inc.*, 694 F.3d 1344 (Fed. Cir. 2012) (holding claims obvious based on an inherent property of the claimed formulation).

Similarly, expected properties of claimed compositions are inherently obvious. *Acorda Therapeutics, Inc. v. Roxane Labs., Inc.*, 903 F.3d 1310 (Fed. Cir. 2018). Claims drawn to measurements or functional limitations that are not

unexpected are likewise obvious. *In re Couvaras*, 70 F.4th 1374 (Fed. Cir. 2023) (“[n]ewly discovered results of known processes directed to the same purpose are not patentable because such results are inherent.”). That is because where a property is inherent, “there is no question of a reasonable expectation of success in achieving [the property].” *Hospira, Inc. v. Fresenius Kabi USA, LLC*, 946 F.3d 1322, 1332 (Fed. Cir. 2020).

“To hold otherwise would allow any formulation—no matter how obvious—to become patentable merely by testing and claiming an inherent property.” *Santarus, Inc. v. Par Pharm. Inc.*, 694 F.3d 1344, 1354 (Fed. Cir. 2012). That is exactly what the patent applicant did here: tested and claimed an inherent property—the plastic deformation rate of a known material.

Here, PO made clear in the Chinese file history that the plastic deformation properties tested and claimed were *not* unexpected. *See Couvaras*, 70 F.4th 1374; *Hospira*, 946 F.3d at 1332. Specifically, in response to a “lack of support” rejection from the Examiner of the Chinese parent application, PO stated:

Even though the present application merely discloses the preparation of a porous substrate using a PE having a molecular weight of 1,000,000, it should be known to those skilled in the art that the plastic deformation rate of the porous substrate is mainly affected by the stretching conditions in the process of preparation. Given that the description of the present application has revealed the preparation process, and the examples of the present application have indicated

the components and molecular weight of the selected raw materials, it would be known to those skilled in the art that for porous substrates with different materials and molecular weight, their desired absolute plastic deformation rates can be obtained by changing a stretching ratio.

EX1008, 0024.

Additionally, '927 patent Table 1 provides test results for the absolute plastic deformation rates of several examples of the claimed separators (porous substrate with porous layer) and discloses no unexpected results. *Compare, e.g., Example 1 with Examples 6, 28, 30, 36-40.* Accordingly, the plastic deformation rate range of the porous substrate is not novel or unexpected. EX1003, ¶139. Nor is a particular stretching ratio or manufacturing process claimed. A POSA would readily know how to obtain a substrate with the desired absolute plastic deformation rate—an inherent property of the substrate itself imparted by the manufacture process (as defined by the '927 patent). *Id.*

Nishikawa similarly describes the materials, molecular weight, and preparation process for its porous substrate. EX1004, [0044],[0047]. By PO's own admission, a POSA would therefore know how to obtain a plastic deformation rate within the claimed range for any of Nishikawa's example substrates, at least by manipulating the stretching ratio. EX1003, ¶140.

Moreover, several of Nishikawa's example substrates (including Example 1 as discussed above) necessarily have absolute and relative plastic deformation rates within the claimed ranges, as would be expected in view of their other properties as disclosed in Nishikawa's Table 1. *Id.* Accordingly, to the extent the Board finds that these numeric values are not explicitly or inherently anticipated by Nishikawa, they are nonetheless obvious in view of Nishikawa's disclosure of the method of manufacture, molecular weight, tensile strength, elongation, and Young's modulus.

B. Ground 2B: Nishikawa in view of Chen renders claims 1-10 obvious.

Nishikawa and Chen are analogous art as they both disclose lithium ion battery separators comprising a polyethylene porous substrate coated with a porous layer. PO and assignee of the Nishikawa patent is Tejin Limited, a Japanese company that manufactures and sells lithium battery separators. EX1003, ¶141. Chen tests multiple lithium battery separators, including a Teijin separator. EX1005, 14905 (Table 1). These tests include stretching and breaking the separators as discussed in the '927 patent. EX1001, 10:25-43.

Chen displays the results of its tests by plotting a stress-strain curve for each separator. EX1005, FIG. 3, 14908. Stress-strain curves depict the elastic and plastic deformation of a material in a numbered graph—explicitly disclosing the absolute and relative plastic deformation rates (as those terms are defined in the '927 patent). EX1003, ¶142.

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If it is alleged that Nishikawa does not explicitly and inherently (Ground 1) or obviously (Ground 2A) teach all claim features, a POSA could look to Chen to learn more detail about the elastic and plastic deformation properties of the kind of separators described in Nishikawa. *Id.* After viewing Chen, a POSA would have supplemented Nishikawa's disclosure with Chen's disclosure of battery separators having clearly depicted absolute and relative plastic strain. A POSA would have an expectation of success in understanding or manipulating the properties of Nishikawa's separators, or of adding Chen's separators to the electrochemical device taught by Nishikawa. *Id.*

1. 1.P

Nishikawa teaches 1.P. Section VIII.A.

2. 1.1

Nishikawa teaches 1.1. Section VIII.B.

3. 1.2

Nishikawa teaches 1.2. Section VIII.C.

4. 1.3

Nishikawa teaches 1.3. Section VIII.D.

5. 1.4

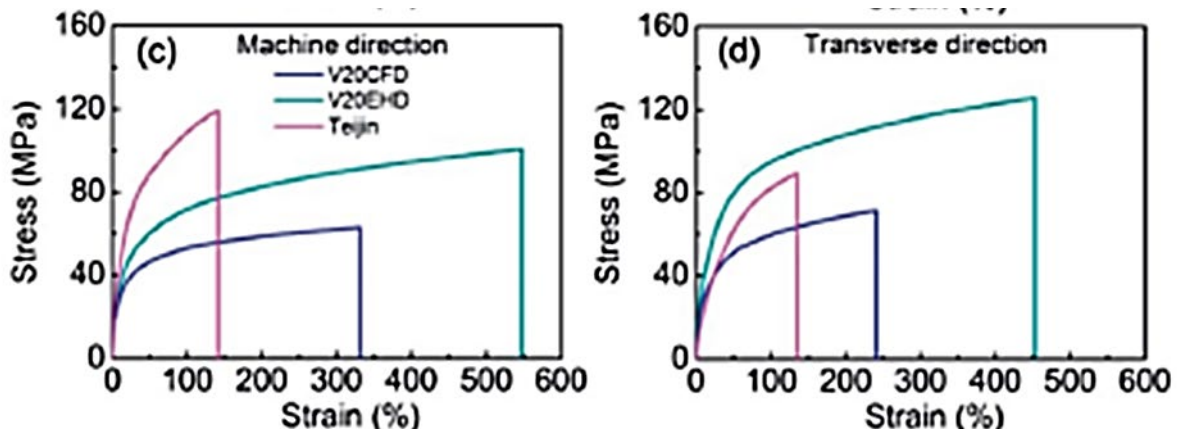
Nishikawa-Chen teaches element 1.4.

a) Nishikawa

To the extent the absolute plastic deformation rates of the Tejin separators disclosed in Nishikawa are not inherent (Ground 1) or obvious (Ground 2A), these values are explicitly disclosed for the Tejin separator described and tested in Chen by virtue of the provided stress-strain curve. EX1003, ¶148; EX1005, FIG. 3, 14908.

b) Chen

Specifically, Chen (FIG. 3, 14908) provides a stress-strain curve for a Teijin porous substrate:



EX1005, 14908, FIG. 3.

EX1003, ¶¶149-151. Chen also gives measured modulus, tensile strength, and strain at break, shown in the table below:

Separator	Direction	Measured modulus ^a (MPa)	Tensile strength (MPa)	Strain that non-linearity occurred (%)	Strain at break (%)
2325	MD	935 ± 43	175.2 ± 9.1	0.79	155.9
	TD	510 ± 24	14.7 ± 1.9	0.61	164.9
2400	MD	873 ± 37	146.5 ± 7.4	0.85	164.3
	TD	502 ± 28	13.4 ± 2.2	0.76	164.2
V20CFD	MD	675 ± 25	65.3 ± 5.3	0.68	333.2
	TD	781 ± 39	72.6 ± 6.7	0.72	241.5
V20EHD	MD	696 ± 48	102.7 ± 7.8	0.65	547.7
	TD	823 ± 52	127.8 ± 9.1	0.87	453.2
Teijin	MD	733 ± 41	120.6 ± 9.6	0.63	142.2
	TD	622 ± 36	90.1 ± 8.5	0.54	134.9

^a The Young's modulus was calculated from the slope of the linear stress-strain curve in the strain range of 0–0.5%.

EX1005, Table 2, 14909.

Chen further analyzes the atomic force microscopy (AFM) images of the separator during deformation to determine the yield strength (elastic strain).

EX1005, 14911. Chen discloses that deformation of the Teijin separator is elastic at small strains (at least up to the point where non-linearity starts, i.e. where the stress-strain curve becomes non-linear). *Id.* By subtracting the yield strength (0.63%) from the elongation at break (142.2%), the plastic deformation rate in the first direction (MD) for the Tejin separator is shown to be 141.57%.

EX1003, ¶¶152-154.

Alternatively, the 0.2% offset method can also be used to estimate the lower boundary of the plastic strain. EX1003, ¶155, EX1018, 61; EX1019, 8; EX1021, 87. To calculate the yield stress, a line with a slope equal to Young's modulus is superimposed on the stress-strain curve provided by Chen. The line and the stress-strain curve intersect at a stress of about 40 MPa. The strain corresponding to this

yield stress (elastic strain) is about 5%. The plastic strain = strain at break - elastic strain = 142.2% - 5% = 137.2%. Thus, the plastic strain in the MD direction is 137.2- 141.57%. EX1003,¶155.

From a different perspective, the Tejin separator in Chen also has the large elongation and small bounce-back property that the '927 patent identifies as being the object of the invention. *Compare* EX1005, 14904 *with* EX1001, 22:19-23:5. Chen explains that “at small strains the deformation was elastic and can be reversed if the load was removed,” while “at higher strains nearly perfect plastic flow behavior occurred.” EX1005, 14911. Even without performing the calculations, a POSA would understand the plastic deformation rate of Chen’s Tejin separator to be within the claimed range. EX1003,¶56 (noting the separator segments about double in size due to predominately plastic deformation). Chen also discloses (on page 14914) that separators manufactured by a wet process show a similar tensile behavior in both MD and TD because the round-like pores collapse from the initial stage of deformation, followed by a failure in a “brittle” fashion. Brittle breaking indicates a small bounce-back. EX1005, 14914.

c) Motivation to Combine (MTC)

Nishikawa and Chen both disclose lithium-ion battery separators comprising a polyethylene porous substrate coated with a porous layer. EX1003,¶156. Specifically, Chen tests the failure and breakage rate of a Teijin battery separator

similar to the one described in Nishikawa. EX1005, Table 1, 14905, Table 2, 14909. These tests include stretching and measuring the separators as discussed in the '927 patent. EX1001, 10:25-43. One of skill reading Nishikawa would therefore look to Chen to learn more about the performance of the separator disclosed in Nishikawa. EX1003, ¶157. One of skill would further expect that the Teijin separator tested in Chen would work in the Teijin battery disclosed in Nishikawa, again because both references disclose different attributes of the same products. *Id.*

Chen displays the results of its tests by plotting a stress-strain curve for each separator. EX1005, FIG. 3, 14908. The curve for the Teijin separator is depicted as a simple convex curve, with an initial steep elastic region, a plastic region gradually tapering off, with highest strain (ultimate tensile strength) at break. EX1003, ¶158. A POSA would be motivated to combine the teachings of Nishikawa and Chen, in part because both Nishikawa and Chen discuss Teijin separators manufactured by similar processes. EX1004, ¶[0045]; EX1005, 14904-14905.

A POSA interested in practicing the separator of Nishikawa would be interested in learning from Chen the performance properties of that separator, including failure and breakage rates, in order to ensure that the resulting separator was appropriate for a given application. EX1003, ¶159. A POSA would also expect

that he could substitute the Teijin separator tested in Chen for the separator disclosed in Nishikawa if desired, since both separators are Teijin products manufactured by similar methods for the same applications. EX1003, ¶160.

Once combined, a POSA would have an expectation of success of the combined teachings. For instance, a POSA would expect that Chen's disclosure of the plastic deformation of the Teijin separator and its influence on failure and breakage could be successfully incorporated into Nishikawa's separator because it is also a Teijin separator manufactured by the same process for the same purpose.

Id. Chen discloses:

separators, the electrochemically inactive components in liquid electrolyte Li-ion batteries, which prevent any physical contact (internal short circuiting) between the anode and cathode electrodes while permitting the free shuttling of lithium ions in the liquid electrolyte between the electrodes throughout the separator's interconnected porous structure.

EX1005, 14904. This is also the same kind of separator disclosed in the '927 patent for the exact same purpose: preventing internal short circuiting by preventing physical contact between the anode and cathode. EX1001, 3:62-65.

Chen similarly explains that it provides a test of "five micro-porous polymer separators," EX1005, 14905, col. 2, including a *Teijin PE substrate* coated with a fluorine based compound (porous layer). This is the same PE substrate disclosed in

Nishikawa, made by the same company as PO and assignee of the Nishikawa patent. EX1003, ¶¶159-160. A POSA would therefore understand that the separator of Nishikawa could be manufactured to have the absolute plastic deformation rates depicted in Chen, and fully expect success at least because both separators are Teijin polyethylene separators with coatings. *Id.*

6. Claim 2

Nishikawa-Chen teaches claim 2.

To the extent it is alleged Nishikawa is deficient, using the same obviousness rationale to combine and value inputs discussed above for 1.4, Chen's Teijin porous substrate has an absolute plastic deformation rate of about 134.36% (strain at break - elastic strain = 134.9% - 0.54%) in the second (TD) direction. EX1003, ¶¶161-62. Alternatively, using the .2% offset method to estimate the upper bound of elastic strain gives a plastic deformation rate of 131.9%. EX1003, ¶163; EX1018, 61; EX1019, 8; EX1021, 87. This is calculated by superimposing a line with a slope equal to Young's modulus onto the stress-strain curve provided by Chen. The line and the stress-strain curve intersect at a yield stress of about 20 MPa and a yield (elastic) strain of about 3%.

Chen therefore discloses the limitations of claim 2, such that Nishikawa-Chen renders claim 2 obvious.

7. Claim 3

Nishikawa-Chen teaches claim 3.

To the extent it is alleged Nishikawa is deficient, using the same obvious rationale to combine and value inputs discussed above for 1.4 and 2, Chen's Teijin separator has both of the listed properties. EX1003, ¶¶164-165. The plastic deformation rate in the first direction (MD) is shown to be about 137.2-141.57% and the second direction (TD) is shown to be 131.9-134.36%. *Id.*

Chen therefore discloses the limitations of claim 3, such that Nishikawa-Chen renders claim 3 obvious.

8. Claim 4

Nishikawa-Chen teaches claim 4.

To the extent the relative plastic deformation rates of the Tejin separators disclosed in Nishikawa are not inherent (Ground 1) or obvious (Ground 2A), using the same obvious rationale to combine and value inputs discussed above, these values are explicitly disclosed for the Tejin separator described and tested in Chen. EX1003, ¶166.

Chen's Teijin porous substrate has a relative plastic deformation rate in the first (MD) direction of $APD/strain \text{ at break} * 100\% = (137.2\% \text{ or } 141.57\%)/142.2\% * 100\% = 96.5\text{-}99.55\%$. EX1003, ¶¶167-168. The porous substrate has a

relative plastic deformation rate in the second (TD) direction of (131.9% or 134.36%/ 134.9% *100% = 97.8-99.60%. *Id.*

Nishikawa-Chen renders claim 4 obvious. EX1003, ¶169.

9. Claim 5

Nishikawa-Chen teaches claim 5.

To the extent the relative plastic deformation rates of the Tejin separators disclosed in Nishikawa are not inherent (Ground 1) or obvious (Ground 2A), using the same obvious rationale to combine and value inputs discussed above, these values are explicitly disclosed in Chen. EX1003, ¶171.

Chen's Teijin porous substrate has a relative plastic deformation rate in the first (MD) direction of 96.5-99.55%. EX1003, ¶172. The porous substrate has a relative plastic deformation rate in the second (TD) direction of 97.8-99.60%. *Id.* The claim uses the term "about" to modify all of the plastic deformation rates to denote up to $\pm 10\%$. EX1001, 12:6-9. The values calculated by Chen are about the claimed ranges. EX1003, ¶172.

Nishikawa-Chen renders claim 5 obvious.

10. Claim 6

Nishikawa teaches claim 6. Section VIII.J.

11. Claim 7

Nishikawa teaches claim 7. Section VIII.K.

12. Claim 8

Nishikawa-Chen teaches claim 8. EX1003, ¶176.

As discussed above for Ground 1, Nishikawa discloses that the porous substrate can include “microporous membranes, porous sheets made of a fibrous material, such as non-woven fabrics and paper-like sheets, and composite porous sheets including such a microporous membrane or porous sheet as well as one or more other porous layers laminated thereon.” EX1004, [0035]. Specifically, the “porous substrate” is “a polyolefin,” like “polyethylene.” EX1004, [0040]-[0043].

If unclear in Nishikawa, using the same obvious rationale to combine and value inputs discussed above, Chen similarly discloses a Teijin battery separator with a porous substrate of polyethylene. EX1005, 14905, Table 1. Chen further discloses, “In the wet process, raw gel-like separator film is first made by extruding a heated homogenous mixture of polymer resins and plasticizers (e.g., paraffin oil, antioxidant, and other additives) into a thin film that is orientated in the MD, which is then followed by extracting the plasticizers from the film with a volatile solvent to leave the polymer pore skeleton in the film which forms the microporous structure.” EX1005, 14905. This is roughly the same manufacturing process disclosed in Nishikawa. EX1003, ¶177.

Nishikawa-Chen renders claim 8 obvious.

13. Claim 9

Nishikawa-Chen teaches claim 9.

a) Nishikawa

As discussed above for Ground 1, Nishikawa Table 1 discloses porous substrates with thicknesses of 9 microns. EX1004, Table 1 (Examples 1-8).

Nishikawa therefore discloses this element. EX1003, ¶179.

b) Chen

If, however, a POSA wanted to make a separator with the plastic deformation disclosed in Chen, then the POSA might choose the thickness of the Chen separator (or substitute the entire Nishikawa separator for the one disclosed in Chen) instead.⁸ EX1003, ¶179. Table 1 of Chen discloses a Teijin separator with a thickness of 15 microns. EX1005, Table 1, 14909. Chen therefore also discloses this element.

⁸ Use of the terms “if” and “might” here refers to the fact that there are many different design choices a POSA would readily envision, all of which would lead to the claimed plastic deformation rates. EX1003, ¶180. All of the design choices (Nishikawa separator, Chen separator, or modified separator) presented above are equally viable and equally anticipate the claim limitations. *Id.*

c) MTC

One of skill in the art would readily understand that the thickness of the porous substrate at least *within the claimed numeric range* is a design choice that balances competing desires such as ion permeability, tensile strength, puncture resistance, weight, and space constraints. EX1003, ¶180. A POSA could readily implement, for example, a 9-micron version of Chen's porous substrate in Nishikawa's battery, or implement a 15-micron version of Nishikawa's porous substrate to obtain the other physical properties of Chen's Teijin separator. Accordingly, a POSA would readily combine the teachings of these references to practice different variations of Teijin separators with different thicknesses, all within the numeric range recited in claim 9, with an expectation of success. *Id.*

Nishikawa and Chen renders claim 9 obvious.

14. Claim 10

Nishikawa discloses claim 10. Section VIII.N.

X. GROUND 3: CLAIMS 1-10 ARE OBVIOUS OVER CHEN IN VIEW ZHANG

As discussed above in Ground 2B, Chen describes various battery separators and provides test results for deformation experiments similar to those recited in the '927 patent. EX1005, Table 2, 14909. In addition to the Teijin separator discussed in Ground 2B, Chen also describes and reports results for a Celgard separator. EX1005, Table 2, 14909. The Celgard separator tested and described in Chen has

the claimed plastic deformation properties as shown in the stress-strain curve.

EX1003, ¶183.

While the Teijin separator described in Chen has a porous layer disposed on the porous substrate, the Celgard separator described in Chen does not. EX1005, Table 2, 14909. The plastic deformation measurements for the Celgard separator thus provide results for the porous substrate alone.⁹ A POSA would readily understand that a porous layer could be added to the porous substrate of the Celgard separator described in Chen, just as one was added to the Teijin separator described in Chen. EX1003, ¶183.

In order to learn the types of porous layers appropriate to add to the Celgard separator in Chen and how to make them, a POSA would look to U.S. Patent No.

⁹ The claim specifies that the recited absolute plastic deformation rate (numeric range) is the plastic deformation rate of the porous substrate itself (as opposed to the separator as a whole). EX1003, ¶¶80-82. All of the nail-test data in the '927 patent, however, show testing of porous substrates with coatings on. EX1001, Table 1. Regardless, the fact that Chen tests the porous substrates of the two Celgard separators without a coating confirms that the calculated plastic deformation applies to the naked porous substrate.

10,559,802 to Zhang. EX1003, ¶184. Zhang is assigned to Celgard, the same company that makes the 2325 and 2400 separators tested in Chen. *Id.* Zhang even describes a Celgard separator like the Celgard separators disclosed in Chen. EX1006, 8:24-26. Zhang goes on to describe a porous layer and teaches that it would be appropriate to add this porous layer to any kind of battery separator, preferably the Celgard separator. EX1006, 8:27-67; 9:1-13. Zhang therefore provides express motivation to combine its teachings with Chen. EX1003, ¶184. Once combined, there would be an expectation of success for that combination. EX1003, ¶195.

A. 1.P

To the extent the preamble is limiting, Chen discloses, “liquid electrolyte Li-ion batteries,” which are electrochemical devices. EX1005, 14904;

Chen discloses 1.P. EX1003, ¶185.

B. 1.1

Chen discloses, “**separators**, the electrochemically inactive components in liquid electrolyte Li-ion batteries, which prevent any physical contact (internal short circuiting) between the **anode** and **cathode** electrodes while permitting the free shuttling of lithium ions in the liquid electrolyte between the electrodes throughout the separator’s interconnected porous structure.” EX1005, 14904 (emphasis added).

Chen discloses 1.1. EX1003, ¶186.

C. 1.2

Chen-Zhang teaches element 1.2.

1. Chen

Celgard separators described and tested in Chen have a porous substrate, but not a porous layer. EX1005, Table 1, 14095. The Tejin separator discussed in Chen has both a porous substrate and a porous layer. *Id.* A POSA would therefore understand from Chen, as well as common knowledge in the art, that adding a porous layer to a porous substrate was a known option and conferred certain advantages to separators. EX1003, ¶187. A POSA would therefore be interested in learning more about layers and coatings that could be added to the Celgard separators disclosed in Chen. *Id.* For this, a POSA would look to Zhang.

2. Zhang

Zhang discloses a porous layer for separators, specifically a porous layer that can be added to a Celgard separator like the Celgard separator disclosed in Chen. EX1006, 2:2-7. The Zhang patent is assigned to Celgard. Zhang teaches that adding its porous layer (ceramic coating) confers several benefits. EX1003, ¶188. Specifically, Zhang teaches that “[t]he formation of an oxidized or reduced interfacial layer between a separator and a battery electrode prevents or stops further oxidation or reduction reactions from occurring and improves the safety,

cycle life and/or the high temperature performance of a lithium ion battery.”

EX1006, 3:18-22.

Zhang describes its “separator membrane or separator for a lithium ion battery” as “includ[ing] a porous or microporous membrane coated with a ceramic coating or layer such as a layer of one or more particles and/or binders.” EX1006, 2:14-19. Zhang’s porous membrane is the “porous substrate” of the claims, and the ceramic layer is the “porous layer” of the claims. EX1003, ¶189. Zhang discloses, “[i]n accordance with at least certain possibly preferred embodiments of the invention, there is provided in a secondary lithium ion battery.” EX1006, 17:35-38. Zhang explains “[o]ne side [of the separator] may be adapted to contact the cathode while the other side may be adapted to contact the anode.” EX1006, 7:64-65.

Zhang goes on to explain, “[t]he preferred membrane, film, base layer, membrane separator or separator may be a microporous polyolefin (PO) substrate that can be made by a dry process (also known as the CELGARD process), wet process, particle stretch process..., or the like.” EX1006, 8:3-7. This is the same polyolefin substrate used in the Celgard separators described in Chen (polyethylene and polypropylene are types of polyolefins). EX1003, ¶190. Zhang also teaches that “the preferred membranes are Celgard brand membranes,”

EX1006, 8:24-25, which are the 2325 and 2400 membranes tested in Chen.

EX1005, Table 1, 14905.

3. MTC

A POSA would have been motivated to apply the coating taught by Zhang to the Celgard porous substrate measured in Chen to arrive at the separator of 1.2.

EX1003, ¶191. As discussed above in Ground 2B, Chen describes various battery separators and provides test results for deformation experiments similar to those recited in the '927 patent. EX1005, 14906-07. In addition to the Teijin separator discussed in Ground 2B (which has a porous layer coating), Chen also describes and reports results for two Celgard separators that do not have a porous layer.

EX1005, Table 2, 14909.

A POSA would readily understand, however, that a porous layer could be added to the porous substrate of the Celgard separator described in Chen, because doing so was extremely common in the art at the time and because a porous layer was added to the Teijin separator also described in Chen, which had improved properties compared to the Celgard separators. EX1003, ¶191. A POSA would have been motivated to apply the coating taught by Zhang to the Celgard porous substrate measured in Chen to improve battery performance and safety.

EX1003, ¶¶194-196. For example, Zhang teaches that “[t]he formation of an oxidized or reduced interfacial layer between a separator and a battery electrode

prevents or stops further oxidation or reduction reactions from occurring and improves the safety, cycle life and/or the high temperature performance of a lithium ion battery.” EX1006, 3:18-22.

Both references disclose the same kinds of polyolefin polymer membranes made by the same dry process, and sold under the same Celgard brand name. EX1003, ¶194. Zhang goes on to describe a porous layer and teaches that it would be appropriate to add this porous layer to the porous substrate of any kind of battery separator, preferably the Celgard separator. EX1006, 8:3-26. A POSA would therefore be motivated to modify the Celgard separator disclosed in Chen to add the porous layer disclosed in Zhang, at least because Zhang teaches a POSA to do *exactly that*. EX1003, ¶194.

Zhang thus also teaches that the separators of Chen and Zhang both have the same purpose and objectives, which are the same purpose and objectives of the ’927 patent. EX1003, ¶196. Both separators aim to provide improved battery life and safety. They are both manufactured by similar methods in order to achieve the properties that both Chen and Zhang attribute to the porous substrates and coatings that they describe in their respective disclosures. EX1005, 14904; EX1006, 2:20-26. Importantly, the reasons that Chen and Zhang provide testing data and manufacturing information for their respective separators is to show the elastic and plastic behavior, which is relevant to nail-test passage rates (a widely accepted

indicator of separator safety). EX1003,¶196. Of course, a porous substrate with high puncture resistance (nail-test aptitude) must also be able to perform the other roles of a separator in a battery (cycle-time, temperature resistance), which is why such separators often have (and are tested with) porous layers applied to the porous separators. *Id.*

Once combined, a POSA would have an expectation of success of the combined teachings, at least because Zhang expressly teaches that its porous layer would be an improvement to the Celgard separator, and teaches that its porous layer is particularly suited to separators manufactured by the Celgard process. EX1003,¶195. Additionally, a POSA would have observed that the Teijin separator of Chen had a similar coating, and would expect that following the teachings of Zhang to modify the Celgard separator and add a similar coating would similarly succeed. *Id.*

D. 1.3

Chen-Zhang teaches 1.3.

1. Chen

Because Chen's Celgard separators do not have a coating, Chen does not teach any specific components of a porous layer disposed on those substrates. EX1003,¶197. Chen's Teijin separator has a fluorine compound coating, which a POSA would understand to include inorganic particles of fluorine and a binder to

adhere them to the porous substrate. EX1005, Table 1, 14905. Thus, while Chen itself suggests that coatings including inorganic components are desirable for separators generally, it does not disclose any particular coating for the Celgard separators tested. Zhang, however, discloses this limitation.

2. Zhang

Zhang discloses, “[t]he ceramic coating is preferably made up of, includes or is comprised of one or more ceramic particles or materials mixed with one or more aqueous or water based binders, polymers, polymeric binders, or the like.”

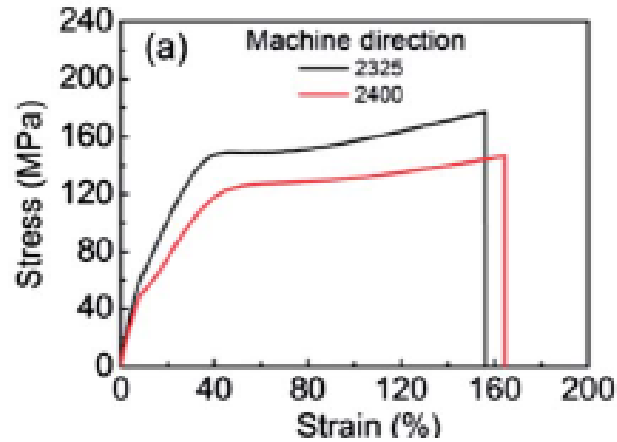
EX1006, 8:27-30. Ceramic particles are inorganic particles. EX1003, ¶198.

3. MTC

A POSA would be motivated to look to Zhang for details on how to make and apply the porous layer and find the combination obvious as discussed for 1.2. EX1003, ¶199. A POSA would be motivated to apply the specific coating taught in Zhang for the same reasons that Zhang motivates a POSA to use coatings generally—to improve the safety and performance of the battery. EX1006, 3:18-22.

E. 1.4

Chen discloses stress-strain curves and Young’s moduli for two Celgard porous separators, denoted “2325” and “2400.” FIG. 3 shows the stress-strain curves in the MD (first direction). EX1003, ¶200-202.



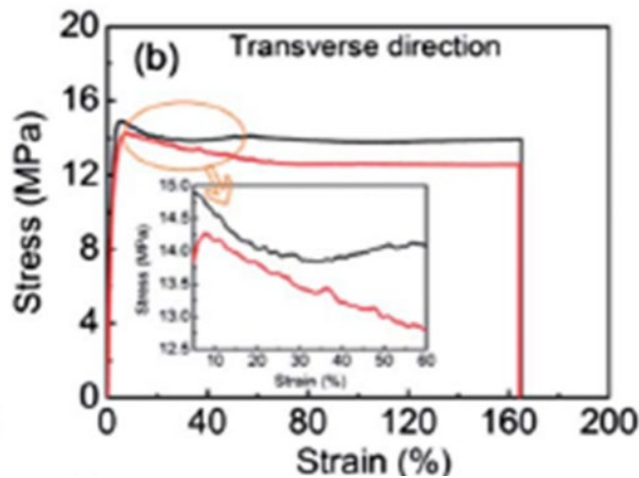
EX1005, FIG. 3 (excerpted).

Chen further uses AFM images to determine the yield stress of the separators. EX1003, ¶203. Elastic strain is equal to the strain observed at the yield stress. *Id.* Chen explains that yielding occurs at about 35% strain for both the 2325 and 2400 Celgard separators. EX1005, 14910. The yield strain for both separators is also read directly from the stress-strain curves. EX1003, 203. The elastic strain is then subtracted from the elongation at break to determine the absolute plastic deformation rate. EX1003, ¶203. For the 2325 separator, the absolute plastic deformation rate in the MD is $155.9\% - 35\% = \mathbf{120.9\%}$. For the 2400 separator, the absolute plastic deformation rate in the MD is $164.3\% - 35\% = \mathbf{129.3\%}$. Both of these values fall within the claimed numeric range.

Therefore, Chen-Zhang renders obvious all the features of claim 1.

F. Claim 2

Chen FIG. 3 also discloses stress-strain curves for the 2325 and 2400 Celgard separators in the TD (second direction). EX1003, ¶205.



EX1005, FIG. 3 (excerpted).

In the TD, the 2325 and 2400 separators experience plastic deformation (necking, strain softening) at a very early stage of deformation (~8%). EX1005, 14908-09. Thus elastic deformation only occurs at strains less than 8%. EX1003, ¶206.

For the 2325 separator, the absolute plastic deformation rate in the TD is $164.9\% - 8\% = 156.9\%$. EX1003, ¶207. For the 2400 separator, the absolute plastic deformation rate in the TD is $164.2\% - 8\% = 156.2\%$. *Id.* Both of these plastic deformation rates fall within the claimed numeric range. EX1003, ¶209.

Chen discloses claim 2.

G. Claim 3

As discussed above for 1.4 and claim 2, the absolute plastic deformation rates of the two Celgard separators tested in Chen fall within these numeric ranges. EX1003, ¶210.

Chen discloses claim 3.

H. Claim 4

The Celgard separators tested in Chen have relative plastic deformation rates that fall within the claimed ranges. EX1003, ¶211. As taught by the '927 patent, the *relative* plastic deformation rate is simply the absolute plastic deformation rate divided by the total strain (i.e., elongation at break). EX1001, 4:47-55.

For the Celgard 2325 separator, the relative plastic deformation rate in the MD (first direction) is 77.5% and in the TD (second direction) is 95.1%. EX1003, ¶212. For the 2400 separator, the relative plastic deformation rate in the MD is 78.7% and in the TD is 95.1%. *Id.* All of these numeric values fall completely within the claimed ranges.

Chan discloses claim 4.

I. Claim 5

As discussed above for claim 4, the Celgard 2325 has a relative plastic deformation rate in the MD of 77.5% and the 2400 separator has a relative plastic deformation rate in the MD of 78.7%. EX1003, ¶214. Both the 2400 and 2325 Celgard separators thus have relative plastic deformation rates that fall within the claimed numeric range for the first direction. *Id.* Claim 5 only requires that the porous substrate satisfy at least *one* of the recited numeric ranges (i.e. one direction). It need not have both.

Chen discloses claim 5.

- J. Claim 6. The electrochemical device according to claim 1, wherein the binder comprises at least one selected from the group consisting of . . . , **polyacrylic acid**, polyacrylate, **polyacrylonitrile**, polyvinyl pyrrolidone, **polyvinyl acetate**, . . . , **polyvinyl alcohol**, . . .**

Chen-Zhang teaches claim 6.

Chen does not expressly disclose a porous layer applied to the Celgard separators, but Zhang does. Section X.C.

A POSA would be motivated to apply Zhang's porous layer to Chen's Celgard separators and find the combination obvious as discussed above for 1.2. For those same reasons, a POSA would be motivated to select a porous layer as Zhang describes it, including Zhang's selection of the binder. EX1003, ¶215.

Zhang discloses: "The preferred water based polymeric binder can be **polyvinyl alcohol** (PVOH), **polyvinyl acetate** (PVAc), **polyacrylic acid salt**, **polyacrylonitrile**, ... or copolymers of the above or blends or mixtures of the above." EX1006, 8:61-65.

Zhang discloses claim 6, EX1003, ¶216, so Chen-Zhang renders claim 6 obvious.

- K. **Claim 7.** The electrochemical device according to claim 1, wherein the inorganic particles comprise at least one selected from the group consisting of **alumina**, **silica**, magnesium, **titanium** oxide, . . ., **zinc** oxide, calcium oxide, **zirconia**, yttria, **silicon carbide**, . . .

Chen-Zhang teaches claim 7.

As discussed above, Chen does not expressly disclose a porous layer applied to the Celgard separators, but Zhang does. Section X.C.

A POSA would be motivated to apply Zhang's porous layer to Chen's Celgard separators and find the combination obvious as discussed above for 1.2. For those same reasons, a POSA would be motivated to select a porous layer as Zhang describes it, including Zhang's selection of the inorganic particles.

EX1003,¶217.

Zhang discloses, "The ceramic particles may be inorganic or organic, preferably inorganic. Non-limiting exemplary examples of inorganic particles are **oxides of silicon** (SiO_2), **alumina** (Al_2O_3), **zirconium**, **titanium** (TiO_2) or **zinc** or mixtures thereof or **carbonates of silicon**, ... and blends or mixtures thereof. A preferred particle is Al_2O_3 ." EX1006, 8:30-36. Zhang thus discloses several of the inorganic particles disclosed in the Markush group recited in claim 7.

EX1003,¶218.

Chen-Zhang renders claim 7 obvious.

- L. Claim 8.** The electrochemical device according to claim 1, wherein the porous substrate comprises a polymer film, a multilayer polymer film . . . formed by any one or more of the following polymers: polyethylene, polypropylene, ...

Chen discloses that the Celgard 2325 porous substrate is a tri-layer substrate of polypropylene and polyethylene. EX1003, ¶219. The Celgard 2400 porous substrate is made from polypropylene. EX1005, Table 1, 14905. Chen further characterizes these dry-process separators (the Celgard separators) as films. EX1005, 14905.

Chen discloses claim 8.

M. Claim 9

Chen discloses that the Celgard 2325 and 2400 porous separators both have a thickness of 25 microns. EX1005, Table 1, 14905. This thickness falls within the numeric range of claim 9. EX1003, ¶220.

Chen discloses claim 9.

N. Claim 10

Chen discloses that the devices taught are “electrochemically inactive components in liquid electrolyte Li-ion batteries.” EX1005, 14904.

Chen discloses claim 10. EX1003, ¶221.

XI. THERE ARE NO FACTORS UNDER SECTIONS 325(D) OR 314(A) THAT WEIGH AGAINST INSTITUTING TRIAL

Petitioner presents substantially different prior art and arguments than those previously considered by the Office. 35 U.S.C. § 325(d); *Advanced Bionics, LLC v. MED-EL Elektromedizinische Geräte GmbH*, IPR2019-01469, Paper 6 at 7-10 (PTAB Feb. 13, 2020) (precedential).

Petitioner's prior-art references were not previously considered by the Office during original prosecution. Petitioner's prior art and Grounds materially differ from those previously considered by the Office.

PO asserts the '927 patent against Petitioner in related litigation filed September 6, 2024. EX1013. IPR should be instituted under *Fintiv* regardless. *Apple Inc. v. Fintiv, Inc.*, IPR2020-00019, Paper 11 (PTAB Mar. 20, 2020) (precedential). Petitioner files this Petition before the January 20, 2025 deadline to answer. EX1014. The parties have invested little resources and timing remains uncertain, so this proceeding will help resolve the parties' dispute. The Petition sets forth compelling patentability challenges, overriding any *Fintiv* concerns. 2024-6-21 Vidal Memo, 2-3. If IPR is instituted, Petitioner stipulates not to pursue in the related litigation the Grounds in this Petition or any other ground Petitioner reasonably could have raised in this Petition. *Id.*, 3; *Sotera Wireless, Inc. v. Masimo Corp.*, IPR2020-01019, Paper 12 (PTAB Dec. 1, 2020) (precedential as to § II.A).

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

Real Party-in-Interest (37 C.F.R. § 42.8(b)(1)): The real party-in-interest is
Petitioner Zhuhai CosMX Battery Co., Ltd.

Related Matters (37 C.F.R. § 42.8(b)(2)): The '927 patent is currently at
issue in the litigation *Zhuhai CosMX Battery Co., Ltd., v. Ningde Amperex
Technology Limited*, Case No. 2:24-cv-00728 (E.D. Tex.), filed September 6,
2024.

Petitioner is concurrently filing the following additional petitions for *inter
partes* review of patents also at issue in the above-listed litigation:

Proceeding No.	U.S. Patent No.
IPR2025-00432	11,575,148
IPR2025-00405	11,769,910
IPR2025-00389	11,923,498

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Petition for Inter Partes Review of U.S. Patent No. 10,964,927

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Service Information (37 C.F.R. § 42.8(b)(4)): Please direct all
correspondence regarding this Petition to counsel at the above addresses, COSMX-

PTAB@leehayes.com, and PTAB@sternekessler.com. Petitioner consents to service by email at the addresses above.

XIII. PROCEDURAL STATEMENTS

This Petition is filed in accordance with 37 C.F.R. § 42.106(a). Concurrently filed herewith are a Power of Attorney and Exhibit List under 37 C.F.R. §§ 42.10(b) and 42.63(e), respectively. The required fee is paid through Deposit Acct. No. 19-0036 (Customer ID No. 45324). The Office is authorized to charge any fee deficiency, or credit any overpayment, to Deposit Acct. No. 19-0036 (Customer ID No. 45324).

XIV. CONCLUSION

The PTAB should institute *inter partes* review of the '927 patent and find all claims unpatentable.

Respectfully submitted,

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Date: January 16, 2025

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CERTIFICATE OF WORD COUNT (37 C.F.R. § 42.24(d))

1. This Petition for *Inter Partes* Review complies with the type-volume limitation of 14,000 words, comprising 13,861 words, excluding the parts exempted by 37 C.F.R. § 42.24(a)(1).

2. This Petition for *Inter Partes* Review complies with the general format requirements of 37 C.F.R. § 42.6(a) and has been prepared using Microsoft® Word 2016 in 14-point Times New Roman font.

Respectfully submitted,

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Petition for Inter Partes Review of U.S. Patent No. 10,964,927

CERTIFICATE OF SERVICE (37 C.F.R. § 42.6(e))

I certify that the above-captioned **PETITION FOR *INTER PARTES* REVIEW FOR U.S. PATENT NO. 10,964,927** and associated Exhibits 1001-1021 were served in their entireties upon the Patent Owner on January 16, 2025, via FedEx® Express at the following address:

MARQUEZ INTELLECTUAL PROPERTY LAW OFFICE PLLC
1629 K Street, NW, Suite 300
Washington, DC 20006
Patent Owner's Correspondence Address of Record for U.S. Patent No. 10,964,927

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