UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEALS BOARD

OneD Material LLC
Petitioner

v.

Nexeon Limited
Patent Owner

Patent 8,597,831
Issue Date: December 3, 2013

Title: Method of Fabricating Fibres Composed of Silicon or a Silicon-Based Material and Their Use in Lithium Rechargeable Batteries

---

Inter Partes Review No. 2016-01528

PATENT OWNER'S NOTICE OF APPEAL

To the Director of the Patent and Trademark Office:

Petitioner Nexeon Ltd. hereby notices its appeal from the Patent Trial and Appeal Board Final Decision dated February 2, 2018 [Paper 40, attached hereto] in *inter partes* review 2016-01528, and all adverse rulings or orders leading up to the Final Decision.

In addition to other issues that may be raised on appeal, Petitioner states, pursuant to 37 C.F.R. § 90.2(a)(3)(ii), that the appeal may raise one or more of the following legal issues:

(1) Whether the Board erred in finding Claims 1, 3, 8, 11, 13 of U.S. Patent No. 8,597,831 ("the '831 Patent") unpatentable as anticipated by the Gao Thesis;

(2) Whether the Board erred in finding Claims 20, 23 and 25 of the '831 Patent unpatentable as obvious in view of the combination of Gao and Li;

(3) Whether the Board erred in finding Claims 1, 3, and 8 unpatentable as obvious in view of the combination of the Zhou Patent and the Zhou Article;

(4) Whether the Board improperly shifted the burden to the Patent Owner to prove validity of the challenged claims;

(5) Whether the Board erred in denying Patent Owner the right to take Dr. van Schalkwijk's deposition;

(6) In addition to the filing of this Notice of Appeal with the Director, the requisite copies of this notice and all related fees are being filed in the United States Patent Office's Patent Trial and Appeal Board and in the United States Court of Appeals for the Federal Circuit.

No fees are believed to be due to the United States Patent and Trademark Office in connection with this filing, but authorization is hereby given for any required fees to be charged to the Deposit Account No. 13-2940.

Respectfully submitted this 14th day of March, 2018.

Dated: March 14, 2018

Respectfully Submitted,

/S. Richard Carden/
S. Richard Carden
Reg. No. 44,588

James V. Suggs
Reg. No. 50,419

CERTIFICATE OF SERVICE

The undersigned hereby certifies that a copy of the foregoing Nexeon Ltd's PATENT OWNER'S NOTICE OF APPEAL was served on March 14, 2018 by e-mail and overnight mail to the attorney of record for the patent-at-issue at the address below:

Lead counsel:
Jennifer Hayes, Reg. No. 50,845
jenhayes@nixonpeabody.com

Backup counsel:
Ronald Lopez, *pro hac vice*
rflopez@nixonpeabody.com

/S. Richard Carden/
S. Richard Carden

Trials@uspto.gov
Tel: 571-272-7822
Paper 40
Entered: February 2, 2018

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

ONED MATERIAL LLC,
Petitioner,

v.

NEXEON LIMITED,
Patent Owner.

Case IPR2016-01528
Patent 8,597,831 B2

Before JON B. TORNQUIST, CHRISTOPHER M. KAISER, and JEFFREY W. ABRAHAM, *Administrative Patent Judges.*

TORNQUIST, *Administrative Patent Judge*.

FINAL WRITTEN DECISION

35 U.S.C. § 318(a) and 37 C.F.R. § 42.73

I. INTRODUCTION

A. Background

OneD Material LLC ("Petitioner") filed a Petition (Paper 8, "Pet.") requesting *inter partes* review of claims 1–3, 5–8, 10, 11, 13, 14, 16, 17, 19, 20, 22, 23, and 25 of U.S. Patent No. 8,597,831 B2 (Ex. 1001, "the '831 patent"). Nexeon Limited ("Patent Owner") did not file a Preliminary Response to the Petition.

Upon consideration of the Petition, we determined that Petitioner had demonstrated a reasonable likelihood that it would prevail with respect to claims 1, 3, 7, 8, 11, 13, 20, 23, and 25 of the '831 patent. Thus, we instituted *inter partes* review with respect to those claims. Paper 10, 24 ("Institution Decision" or "Inst. Dec."). We did not institute review, however, with respect to claims 2, 5, 6, 10, 14, 16, 17, 19, and 22 of the '831 patent. *Id.* at 23.

Subsequent to our Institution Decision, Patent Owner filed a Patent Owner Response (Paper 12, "PO Resp."), to which Petitioner filed a Reply (Paper 15, "Pet. Reply"). We also authorized Patent Owner to file a Sur-Reply (Paper 20, "Sur-Reply"). In support of their respective arguments, Petitioner relies upon the declaration testimony of Drs. Walter van Schalkwijk (Ex. 1003) and Otto Zhou (Exs. 1004 and 1031) and Patent Owner relies upon the testimony of Dr. George Blomgren (Ex. 2001).[1]

---

[1] Patent Owner filed a Motion to Exclude portions of Drs. Zhou's and van Schalkwijk's declaration testimony, as well as portions of Dr. Blomgren's cross-examination testimony relied upon in Petitioner's Reply. Paper 22. On September 25, 2017, however, Patent Owner withdrew this Motion to Exclude. Paper 33, 1.

An oral hearing was held on September 20, 2017, and a transcript of the oral hearing is included in the record. Paper 39 ("Tr.").

We have jurisdiction under 35 U.S.C. § 6 and this Final Written Decision is entered pursuant to 35 U.S.C. § 318(a) and 37 C.F.R. § 42.73.

B. Related Proceeding

The parties identify the following proceeding as a related matter: *Nexeon Limited v. EaglePicher Technologies, LLC and OneD Material LLC.*, C.A. No. 1:15-cv-00995-RGA (D.Del). Pet. 2; Paper 4, 2.

C. The '831 Patent

The '831 patent, titled "Method of Fabricating Fibres Composed of Silicon or a Silicon-Based Material and their Use in Lithium Rechargeable Batteries," discloses an electrode (anode) composed of silicon fibers, a binder, and an electronic additive. Ex. 1001, at [54], 1:1–5, 2:38–42.

The '831 patent notes that attempts to use silicon powder in combination with an electronic additive and an appropriate binder, such as polyvinylidene difluoride (PVDF), have failed to show sustained capacity when the resulting electrode is subjected to multiple charge/discharge cycles. *Id.* at 1:64–2:2. "It is believed that this capacity loss is due to partial mechanical isolation of the silicon powder mass arising from the volumetric expansion/contraction associated with lithium insertion/extraction into and from the host silicon." *Id.* at 2:2–6. The '831 patent reports, however, that by arranging silicon or silicon-based fibers in a composite structure with a polymer binder and an electronic additive, "the charge/discharge process becomes reversible and repeatable and good capacity retention is achieved." *Id.* at 2:35–42.

In a preferred embodiment, the process of forming the electrode includes mixing silicon fibres with an n-methyl pyrrolidinone (NMP) casting solvent, a PVDF binder, and a conductive carbon additive to form a homogenous slurry. *Id.* at 4:55–5:1. This slurry is then applied to a metal plate and heated to elevated temperatures to evaporate the casting solvent. *Id.* at 4:65–5:1. The ’831 patent explains that the “mat or composite film” resulting from this process “has a porous and/or felt-like structure in which the mass of silicon fibres is typically between 70 percent and 95 percent.” *Id.* at 4:33–36 (describing the properties of a similar mixture and coating), 5:2–3. The ’831 patent further explains that, “[b]y laying down the fibres in a composite or felt or a felt-like structure, that is a plurality of elongate or long thin fibres which crossover to provide multiple intersections . . . the problem of charge/discharge capacity loss is reduced.” *Id.* at 3:4–9; *see also id.* at 2:35–38 (“Because the anode electrode structure uses fibres of silicon or silicon-based material, the problems of reversibly reacting these silicon or silicon-based fibres with lithium are overcome.”). A scanning electron micrograph (SEM) of such a composite silicon electrode (formed without the conductive carbon component) is depicted in Figure 2 of the ’831 patent, which is reproduced below. *Id.* at 4:38–39.

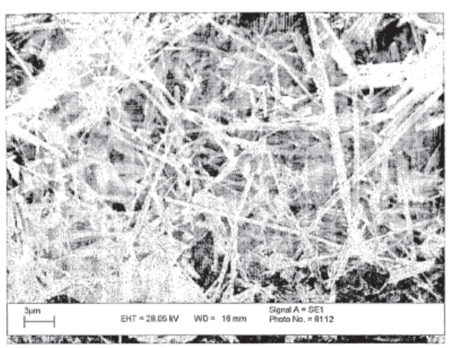

Figure 2 is a magnified photograph of the electrode of the ’831 patent, formed without a conductive carbon additive.

According to the ’831 patent, the structural strength of the disclosed electrode actually “increases with each recharging operation.” *Id.* at 5:21–23. “This is because the fibres are found to ‘weld’ to one another as a result of the disrupted crystalline structure at the fibre junctions creating an amorphous structure.” *Id.* at 5:23–25. These welds reduce the risk of mechanical isolation of the fibres and help to prevent capacity loss over multiple charge/discharge cycles. *Id.* at 5:25–28.

D. Illustrative Claim

Independent claim 1 is illustrative of the challenged claims and is reproduced below:

> 1. An electrode for an electrochemical cell, the electrode comprising an electrically interconnected mass comprising:
>
> elongated structures, wherein the elongated structures are capable of being reversibly charged and discharged and at least some of the elongated structures cross over each other to provide intersections and a porous structure, and wherein the elongated structures comprise silicon;
>
> at least one of a binder and an electronic additive;
>
> wherein the elongated structures and the at least one of the binder and the electronic additive cooperate to define a porous composite electrode layer.

Ex. 1001, 5:50–60.

E. Instituted Grounds of Unpatentability

We instituted trial with respect to the following grounds of unpatentability (Inst. Dec. 24):

Reference(s)	Basis	Claim(s)
Gao Thesis[2]	§ 102	1, 3, 7, and 8
Zhou Patent[3] and Zhou Article[4]	§ 103	1, 3, 7, and 8
Gao Thesis and Zhou Patent or the Zhou Patent and Zhou Article	§ 103	11
Gao Thesis and Winter[5] or Zhou Patent, Zhou Article, and Winter	§ 103	13
Gao Thesis and Li[6]	§ 103	20, 23, and 25

II. ANALYSIS

A. Claim Construction

In an *inter partes* review, a claim in an unexpired patent shall be given its broadest reasonable construction in light of the specification of the patent in which it appears. *See* 37 C.F.R. § 42.100(b); *Cuozzo Speed Techs., LLC v. Lee*, 136 S. Ct. 2131, 2142, 2144–45 (2016) (upholding the use of the broadest reasonable interpretation standard). In determining the broadest reasonable construction, we presume that claim terms carry their ordinary and customary meaning. *See In re Translogic Tech., Inc.*, 504 F.3d 1249,

[2] Gao, Bo, *Synthesis and Electrochemical Properties of Carbon Nanotubes and Silicon Nanowires*, CHAPEL HILL 2001 (“Gao Thesis”). EXS. 1012/1015.

[3] U.S. Patent No. 6,514,395 B2 to Zhou et al., issued February 4, 2003 (“Zhou Patent”). Ex. 1009.

[4] Gao et al., *Alloy Formation in Nanostructured Silicon*, 13 ADV. MATER. (11) 816–19 (2000) (“Zhou Article”). Ex. 1010.

[5] Winter et al., *What Are Batteries, Fuel Cells, and Supercapacitors?* 104 CHEM. REV. (10) 4245–269 (2004) (“Winter”). Ex. 1019.

[6] Li et al., *The Crystal Structural Evolution of Nano-Si Anode Caused by Lithium Insertion and Extraction at Room Temperature*, 135 SOLID STATE IONICS 181–191 (2000) (“Li”). Ex. 1008.

1257 (Fed. Cir. 2007). A patentee may define a claim term in a manner that differs from its ordinary meaning; however, any special definitions must be set forth in the specification with reasonable clarity, deliberateness, and precision. *See In re Paulsen*, 30 F.3d 1475, 1480 (Fed. Cir. 1994).

In the Institution Decision, we construed the term "welds" to mean "merging, fusing, joining, or coalescing of intersecting fibers or nanowires." Inst. Dec. 6–7. Patent Owner contends this preliminary construction should be narrowed to specify that the merging, fusing, etc. of fibers happens "at the fibre-to-fibre contacts of the intersections." PO Resp. 11. Patent Owner also asserts that the term "disrupted crystalline," which was not expressly construed in the Institution Decision, should be limited to "a material that has a crystalline structure that is disrupted from conventional single- or polycrystallinity as a result of having gone through a charging operation." *Id.* at 8–11.

During oral argument, the Board also raised questions regarding the correct scope of the claim limitation "wherein the elongated structures comprise silicon," and subsequently invited additional briefing from the parties on this issue. Paper 32, 1–2. In response, Petitioner and Patent Owner filed opening briefs (Papers 35 and 34, respectively), as well as corresponding responses (Paper 37 (Patent Owner) and Paper 38 (Petitioner)). In its briefing, Petitioner contends the broadest reasonable construction of "wherein the elongated structures comprise silicon" would include "other elements, such as, for example, a carbon-coating on a silicon-core." Paper 35, 3. Patent Owner contends the term should not be construed so broadly as to include a carbon coating on the surface of a silicon nanowire, especially if that coating is formed from a separately recited claim element. Paper 34, 2–5, 10.

Upon review of the record as a whole, we determine that the term "welds" does not require further clarification, and the terms "disrupted crystalline" and "wherein the elongated structures comprise silicon" do not need to be expressly construed, because, for the reasons discussed below, Petitioner has demonstrated by a preponderance of the evidence that the relevant challenged claims are unpatentable even under Patent Owner's proposed constructions. *See Vivid Techs. Inc. v. Am. Sci. & Eng'g, Inc.*, 200 F.3d 795, 803 (Fed. Cir. 1999) ("[O]nly those terms need be construed that are in controversy, and only the extent necessary to resolve the controversy.").

B. Principles of Law

A prior art reference anticipates a claim if it expressly or inherently discloses each limitation of the claim. *In re Cruciferous Sprout Litig.*, 301 F.3d 1343, 1349 (Fed. Cir. 2002). When a reference is silent about an asserted inherent characteristic, "such a gap in the reference may be filled with recourse to extrinsic evidence" showing the "missing descriptive matter is necessarily present in the thing described in the reference." *Cont'l Can Co. USA v. Monsanto Co.*, 948 F.2d 1264, 1268 (Fed. Cir. 1991).

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

C. Anticipation of Claims 1, 3, 7, and 8 by the Gao Thesis

Petitioner contends claims 1, 3, 7, and 8 of the ’831 patent are anticipated by the Gao Thesis. Pet. 17–28.

1. Gao Thesis

The Gao Thesis describes the fabrication of “nanostructured Si (n-Si) materials” and electrodes formed from these nanostructured silicon materials. Ex. 1012, 103–107.[7]

In the fabrication process of the Gao Thesis, a sintered silicon powder containing 10 % iron is ablated with a laser at 1150°C under a constant argon flow. *Id.* at 103. This process produces both silicon nanowires and nanoparticles, in a ratio of 2:1, with the nanoparticles being composed primarily of iron disilicide. *Id.* at 104; Ex. 1006, 210 (asserting that the nanomaterials formed from the disclosed laser ablation process are $FeSi_2$); Ex. 2001 ¶¶ 24–25, 38. The outer surface of the silicon nanoparticles is “typically covered by amorphous oxides” and the “average oxygen concentration” in the silicon nanomaterials is estimated to be 10 wt. %. Ex. 1012, 104.

---

[7] We cite to the internal page numbers of the Gao Thesis. We further note that Petitioner has filed the University of North Carolina library copy of the Gao Thesis as Exhibit 1015, because the images in that copy are of higher quality than those in Exhibit 1012. Pet. 18 n.2.

Figure 6.1(A) of the Gao Thesis, reproduced below, is a picture of the as-synthesized silicon nanowires. *Id.* at 103–04.

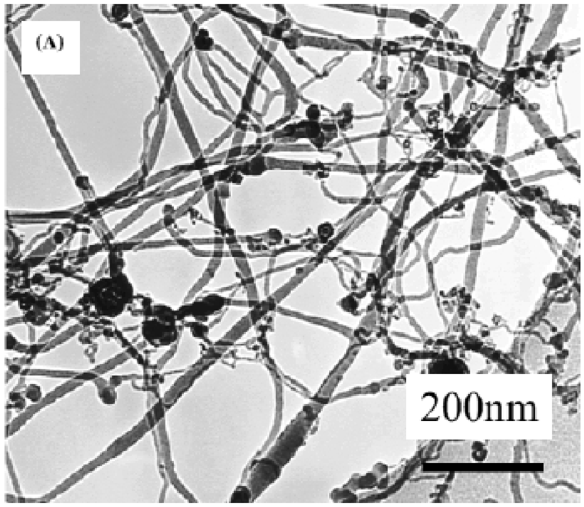

Figure 6.1(A) is a "[t]ypical transmission electron microscopy (TEM) picture[]" of the as-synthesized nanostructured materials (*id.* at 104).

As shown in Figure 6.1(A), the as-synthesized silicon nanowires are elongated in structure and cross over one another at multiple points. *Id.*; Ex. 1003 ¶ 94.

In order to form electrodes, the silicon nanowires were mixed with 5 wt. % conducting carbon black and 5 wt. % PVDF binder. Ex. 1012, 106. This mixture was then suspended in methanol, stirred to form a uniform suspension, dispersed on "flat ~1cm diameter stainless steel plates," and air dried. *Id.* The resulting electrodes were then "processed by annealing at different temperatures up to 900 °C in dynamic vacuum (5 x 10^{-7} torr) for several hours." *Id.* at 106–07.

A picture of the completed electrode was not provided in the Gao Thesis. Figure 3.3 of the Gao Thesis (reproduced below), however, depicts an electrode formed via a similar process, but using no carbon additive and single walled carbon nanotubes (SWNTs) in place of silicon nanowires (*Id.* at 46):

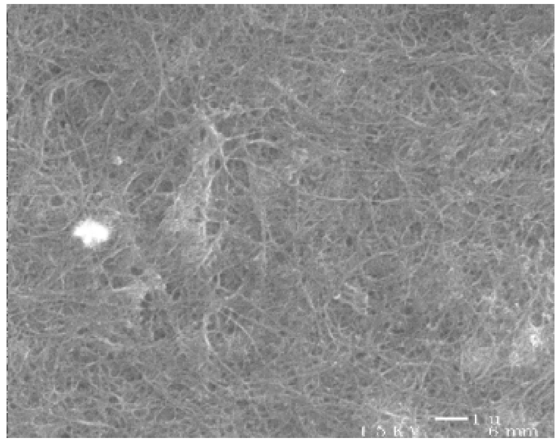

Figure 3.3 is a "[t]ypical" SEM picture of the SWNT electrode (*id.* at 46).

After the silicon nanowire electrode was formed, it was assembled into an electrochemical cell for electrochemical testing. *Id.* at 47–48, 107. Figure 3.4 of the Gao Thesis generally depicts this electrochemical cell:

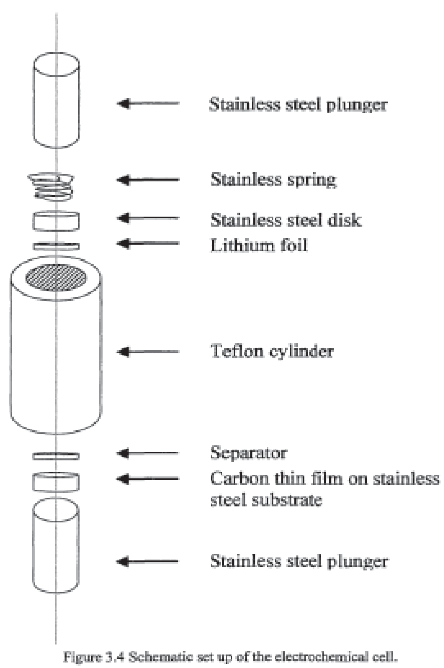

Figure 3.4 is a schematic of the electrochemical cell.

As shown in Figure 3.4, the electrochemical testing cell included two working electrodes that were loaded and sealed in a hollow Teflon cylinder. *Id.* at 47–48. In the silicon nanowire electrode embodiment, these electrodes comprised a lithium metal negative electrode and a silicon nanowire electrode, which replaced the carbon thin film electrode depicted in Figure 3.4. *Id.* at 47–48, 107; Ex. 1003 ¶ 89. The two electrodes were "separated by a ~0.3 mm thick porous glass microfiber filter (Whatman) soaked with the electrolyte" and, "[t]o ensure physical contact between the cell components, a stainless steel spring" providing "pressures of about 1 kg/cm^2" was placed between the stainless steel disk and the second plunger. Ex. 1012, 47–48.

The Gao Thesis reports that the constructed electrode had a "very large reversible Li storage capacity" of 800 mAh/g (or $Li_{0.84}Si$) and "low reaction/extraction voltages," which makes "n-Si and n-Si/Li compounds attractive for Li storage applications." *Id.* at 115.

2. Analysis

a. Claim 1

Petitioner presents evidence that the silicon nanowire electrode of the Gao Thesis is comprised of an electrically interconnected mass of silicon nanowires, or "elongated structures," that are capable of being reversibly charged and discharged. Pet. 17–24; Ex. 1004 ¶¶ 12–19; Ex. 1012, 103–104 (elongated structures composed of silicon), 114–115 (reversible charging and discharging of the electrodes). Petitioner also presents evidence that the disclosed electrode contains both a binder (PVDF) and an electronic additive (carbon black) and that "at least some" of the silicon nanowires in the disclosed electrode cross over one another to provide intersections and a porous structure. Pet. 20–25; Ex. 1004 ¶¶ 13 (discussing the use of a binder and a conductive additive), 15–20 (explaining why the silicon nanowires necessarily cross over each other to form a porous structure with intersections); Ex. 1031 ¶¶ 4, 13; Ex. 1012, 106–107 (disclosing the use of a binder and an additive), Figs. 3.3 and 6.1(a). Thus, Petitioner contends the Gao Thesis anticipates claim 1 of the ’831 patent.

Patent Owner contends the Gao Thesis does not anticipate claim 1 because it does not expressly or inherently disclose an anode that has a “porous structure” and “intersections.” PO Resp. 22. We address these arguments in turn.

Porous Structure

Drs. Zhou and van Schalkwijk testify that the electrode of the Gao Thesis, which was formed from a homogenous methanol slurry of silicon nanowires, carbon black, and PVDF binder, necessarily had nanowires that crossed over one another to form a porous structure. Ex. 1003 ¶¶ 52, 58–59, 89–98; Ex. 1004 ¶¶ 15–17; Ex. 1031 ¶ 4; Pet. 20–25; Pet. Reply 13–14. Dr. van Schalkwijk further testifies that the electrode of the Gao Thesis had to be porous in order to allow lithium to migrate to the silicon nanowires and to accommodate the large volume changes of the silicon nanowires during lithiation. Ex. 1003 ¶ 105 (“The porous structure is necessary for two reasons: the accommodation of electrolyte to facilitate the electrochemical reaction and the accommodation of the $SiLi_x$ after the electrode has charged.”); *see* Ex. 1004 ¶¶ 15, 18, 20. Petitioner also asserts that the porous nature of the electrodes is confirmed by Figure 6.1(A) of the Gao Thesis, which depicts a porous structure formed from interconnecting silicon nanowires, and by Figure 3.3 of the Gao Thesis, which depicts a porous electrode formed using a similar method as that used to form the silicon nanowire electrode. Ex. 1003 ¶¶ 92–98, 133; Ex. 1004 ¶¶ 9–10, 17; Ex. 1031 ¶ 4; Pet. 20–24 (citing Ex. 1012, 46, Figure 3.3, 6.1(a)).

Patent Owner asserts "[t]here is no evidence that dispersion of the nanowires, PVDF, and electronic additive from methanol would provide a porous structure formed from the nanowires." PO Resp. 18 (citing Ex. 2001 ¶ 33). According to Patent Owner, "methanol is classified as a 'nonsolvent' of PVDF" and, because PVDF does not dissolve in methanol, "the structure of the electrode" in the Gao Thesis "could be very different than the structures shown in the '831 patent, which were coated from a solvent in which PVDF is soluble." *Id.* at 18–19 (citing Ex. 2001 ¶ 33; Ex. 2005, 3, 5). Dr. Blomgren also testifies that, "[w]hile it might be necessary to have a porous structure to achieve ***efficient*** lithiation of the material," the anodes of the Gao Thesis "exhibited a relatively low first cycle capacity and an even lower reversible capacity," and it is possible that the overall anode had a porous structure "without the nanowires ***themselves*** forming a porous structure." Ex. 2001 ¶ 40; PO Resp. 25–26. Patent Owner also contends that Petitioner's reliance on Figures 3.3 and 6.1(A) of the Gao Thesis is misplaced, as the electrode depicted in Figure 3.3 was not formed using a conductive additive and Figure 6.1(A) does not depict an assembled electrode, only the shape and orientation of the silicon nanowires after laser ablation. PO Resp. 17–18; Sur-Reply 5–6; Ex. 1012, 104 (noting that Figure 6.1(A) depicts the "as-synthesized" silicon nanowires, and not the nanowires arranged in the assembled electrode).

Upon review of the record as a whole, we find that Petitioner has demonstrated sufficiently that the silicon nanowire electrode disclosed in the

Gao Thesis was porous. First, Dr. Zhou persuasively testifies, based on his personal knowledge, that the silicon nanowire electrode of the Gao Thesis, formed from a homogenous mixture of 90% silicon nanowires (and iron material), 5% PVDF binder, and 5% carbon black, was porous.[8] Ex. 1004 ¶¶ 12–13, 15 ("Our electrode containing the Si nanowires, binder and electronic additive was a composite and remained porous when assembled into an electrochemical cell."); Ex. 1031 ¶ 4; *see also* Ex. 1001, Abstract, 5:54–55 (noting in the '831 patent that the elongated structures crossed over one another to "provide intersections and a porous structure").

Dr. Zhou also provides uncontested testimony that "[d]uring the first lithiation cycle, the crystalline structure of the nano-Si phase disappeared completely, indicating full lithiation of the silicon nanowires and silicon nano-particles and the transition to amorphous phase." Ex. 1004 ¶ 18. Dr. van Schalkwijk persuasively testifies that the Gao Thesis electrode must have been porous in order to facilitate such electrochemical reactions between silicon and lithium, as well as to allow for the significant expansion caused during the charge/discharge cycle. Ex. 1003 ¶ 105.

Dr. Blomgren's counter testimony speculating that the electrode of the Gao Thesis may not have been porous is not persuasive. First, Dr. Blomgren testified on cross-examination that he would "presume there would be some pores within" the electrode of the Gao Thesis, but that it was not clear what the overall porosity of the electrode would be. Ex. 1030, 42:16–44:3. The claims, however, do not require any particular level of porosity for the electrode. *See* Ex. 1001, 5:55; Tr. 16:15–23. Thus, Dr. Blomgren's

---

[8] Patent Owner elected not to depose either Dr. Zhou or Dr. van Schalkwijk. Tr. 15:13–18.

testimony presuming "there would be some pores" tends to support Petitioner's arguments that the Gao Thesis electrode was porous.

Second, Dr. Blomgren does not persuasively explain how "full lithiation" of the silicon material during *the first lithiation cycle* would be possible if the structure of the Gao Thesis electrode did not have some degree of porosity between the silicon nanowires. Moreover, Dr. Zhou persuasively testifies that, contrary to the arguments set forth by Dr. Blomgren, the electrode of the Gao Thesis was in fact efficient, providing a first cycle capacity (1,200 mAh/g) that is "not too far from the electrode's theoretical maximum" of 1,636 mAh/g. Ex. 1031 ¶¶ 7–8 (testifying that the difference between the theoretical maximum and the observed capacity for the Gao Thesis electrode was due to unreacted silicon in the $FeSi_2$ nanoparticles).

Finally, we agree with Petitioner and Dr. Zhou that Figure 3.3 of the Gao Thesis further supports the conclusion that the method of randomly orienting the silicon nanowires in the Gao Thesis resulted in a porous electrode. Ex. 1004 ¶ 17; Ex. 1031 ¶ 4. As noted by Petitioner, both the silicon nanowire electrode and the SWNT electrode of the Gao Thesis were formed using overlapping elongated structures. Pet. 20 (citing Ex. 1003 ¶¶ 58, 89–91; Ex. 1004 ¶¶ 15–17); Pet. Reply 6–7. And, although Patent Owner notes that the electrode depicted in Figure 3.3 of the Gao Thesis was formed without a carbon additive or binder, Patent Owner does not explain why these additional components would render the silicon nanowire electrode non-porous. Sur-Reply 5 (asserting, without supporting testimony from Dr. Blomgren, that the method of forming the carbon nanotube electrode depicted in Figure 3.3 "has nothing in common with Gao's preparation of [silicon nanowire] electrodes").

In view of the foregoing, we credit the testimony of Drs. Zhou and van Schalkwijk and find that the silicon nanowire electrode of the Gao Thesis was porous.

Intersections

It is undisputed that the electrode of the Gao Thesis contained hundreds of billions of silicon nanowires. Pet. Reply 13 (citing Ex. 1004 ¶ 16; Ex. 1030, 41:11–15 (Dr. Blomgren agreeing that 600 billion silicon nanowires would be in an electrode formed using four milligrams of nanostructured material)). Drs. Zhou and Van Schalkwijk testify that, because these silicon nanowires were arranged in a disordered, random pattern, "at least some" of the silicon nanowires within the Gao Thesis electrode "must cross over each other and create intersections." Pet. 23; *see also id* at 20–24 (citing Ex. 1003 ¶¶ 92–98; Ex. 1004 ¶¶ 12–20); Pet. Reply 7, 13.

Patent Owner does not dispute that the silicon nanowires of the Gao Thesis electrode crossed over one another to form intersections, but speculates that the elevated annealing temperatures utilized in the Gao Thesis "may" have prevented the silicon nanowires from contacting one another to form silicon-to-silicon intersections. PO Resp. 20 (citing Ex. 2001 ¶¶ 34–35). In support of Patent Owner's argument, Dr. Blomgren testifies that the electrochemical data provided in the Gao Thesis is consistent with a process in which, as temperatures approach between 210 and 355 °C, the PVDF binder melts and flows to coat nanowire surfaces, thereby preventing contact between the individual silicon nanowires. Ex.

2001 ¶¶ 34–35. Then, when the annealing temperature reaches 670 °C, "thermal decomposition of the PVDF" will have sufficiently progressed "to provide carbon that can bridge between nanowires to allow for electrical conductivity and the somewhat higher specific capacities observed by Dr. Gao and coworkers." *Id*. ¶ 35.

Dr. Blomgren also testifies that the comparative cell data provided in the Gao Thesis suggests that the cell fabrication process may have been defective. *Id.* ¶ 36; PO Resp. 21. For example, according to Dr. Blomgren, both the Si electrode and SiO_2 electrode of the Gao Thesis were found to have large hysteresis, implying varying levels of resistance in the electrode, and the voltage range for SiO_2 was "much higher" than that reported in the literature for SiO_x type materials. Ex. 2001 ¶ 36 (citing Ex. 2008, 2–3; Ex. 2009, 2–3; Ex. 2010, 4–5); PO Resp. 21.

In view of these observations, Dr. Blomgren concludes:

> Dr. Gao and coworkers do appear to have fabricated silicon-containing nanowires, and do appear to have fabricated them into anodes having some low level of reversible capacity. However, given the lack of characterization of the laser-ablated material, the highly atypical treatment of the PVDF binder, including the solvent used and the high annealing temperatures used in processing the anode, and the inconsistent electrochemical data, it is unclear just what the structure of the actual as-fabricated anode is, particularly with respect to the porous structure and intersections required to be formed by the nanowires themselves and with respect to the reversible chargeability of the electrically interconnected mass.

Ex. 2001 ¶ 41.

After considering Petitioner's and Patent Owner's arguments and supporting evidence, we find the preponderance of the evidence demonstrates that "at least some" of the silicon nanowires in the Gao Thesis electrode necessarily overlapped to form intersections. As a preliminary matter, we note that Dr. Blomgren is not familiar with the methanol dispersant/high temperature annealing process set forth in the Gao Thesis. Pet. Reply 8, 12 (citing Ex. 1030, 40:15–41:2, 76:21–77:1). For example, during his deposition, Dr. Blomgren testified that he could not describe how the methanol dispersant would interact with the carbon black, PVDF binder, and the nanostructured silicon during the formation of the Gao Thesis electrode, because "[i]t's not a process that I'm familiar with." Ex. 1030, 40:18–41:2. This lack of familiarity with the methods used to form the electrodes of the Gao Thesis tends to diminish the weight we give his testimony and conclusions.

Next, we note the sheer number of overlapping silicon nanowires in the Gao Thesis electrode. Dr. Zhou provides uncontested testimony that the Gao Thesis electrodes contain between 342 and 600 billion silicon nanowires. Ex. 1004 ¶ 16; Ex. 1030, 41:6–42:5. In contrast, claim 1 requires only that "at least some" of these billions of elongated silicon nanowires formed intersections (which we understand to require only that at least two silicon nanowires formed intersections) and Drs. Zhou and van Schalkwijk provide persuasive reasoning as to why "at least some" of the billions of silicon nanowires in the electrode of the Gao Thesis necessarily formed intersections. Ex. 1001, 5:54–55; Ex. 1003 ¶¶ 90, 95–97; Ex. 1004 ¶¶ 15–17 (asserting that the method of forming the electrodes ensured that the silicon nanowires intersected at multiple points where the silicon nanowires overlapped one another and explaining that the 1 kg/cm^2 force imparted by the spring would have further ensured contact between the silicon nanowires); Ex. 1031 ¶¶ 10–13 (asserting that the reversible capacity of the Gao Thesis electrode was better than the electrode described in the ’831 patent and that this reversible capacity demonstrates that the PVDF binder did not prevent contact between at least some of the nanowire intersections); *see also* Ex. 1030, 42:24–43:6 (Dr. Blomgren testifying that he would “assume” at least some of the billions of silicon nanowires in the electrode of the Gao Thesis would be in contact with each other).

Although Patent Owner and Dr. Blomgren do not bear the burden of showing that “at least some of the elongated structures cross over each other to provide intersections,” they have failed to set forth a credible mechanism whereby the PVDF binder could reasonably be expected to prevent *every one* of the hundreds of billions of silicon nanowires from forming intersections, sufficient to rebut the persuasive testimony and evidence set forth by Drs. Zhou and van Schalkwijk. For example, Dr. Blomgren does not explain why the initial process of forming the electrode, prior to annealing, would not result in direct silicon-to-silicon contacts between the hundreds of billions of silicon nanowires.[9] Nor does Dr. Blomgren explain how a melting and flowing PVDF binder could reasonably be expected to prevent contact between *every* one of the billions of silicon nanowires in the Gao Thesis electrode, much less how such a melting binder would penetrate existing silicon-to-silicon contacts.

[9] In its Sur-Reply, Patent Owner speculates that PVDF agglomerations prevented silicon-to-silicon contacts in the electrode of the Gao Thesis. Sur-Reply 6. This attorney argument is not supported by persuasive evidence. Moreover, Dr. Blomgren testifies that if the PVDF binder is present in clumps, “it may not coat the silicon at all” during the annealing process. Ex. 1030, 80:18–81:10.

Dr. Blomgren also does not address the effect of the 1 kg/cm^2 pressure imparted by the spring in the Gao Thesis, which Dr. Zhou contends would ensure contact between at least some of the overlapping silicon nanowires. Ex. 1004 ¶ 17. Dr. Blomgren also does not explain why the allegedly high hysteresis and SiO_2 voltage range reported in the Gao Thesis, even if evidence of some problems with the method of forming the electrodes, would tend to suggest that none of the silicon nanowires formed intersections.

With respect to Dr. Blomgren's observation that reversible capacities increased (to a point) with increasing annealing temperature in the Gao Thesis, Dr. Zhou testifies that this was due to higher annealing temperatures preventing isolation of the silicon nanowires "during the large silicon volume changes of each cycle." Ex. 1031 ¶ 12. Dr. Zhou further testifies that the reversible capacities reported in the Gao Thesis would be understood by one of ordinary skill to indicate "that the nanowires did in fact form at least some intersections with one another, which persisted during the next two cycles." *Id.* ¶ 13. Dr. Zhou's testimony is consistent with the mechanism described in the '831 patent, whereby sustained reversible capacity is the result of physical contact between individual silicon nanowires. Ex. 1001, 2:2–6 (noting that the failure of silicon powders to show sustained capacity when subjected to charge/discharge cycles is due to "partial mechanical isolation of the silicon powder mass arising from the volumetric expansion/contraction associated with lithium insertion/extraction into and from the host silicon"), 3:10–19, 5:21–28 (noting that "mechanical isolation of the fibres" could cause capacity loss over multiple cycles, but that welds at the fibre junctions reduced the risk of such mechanical isolation). In contrast, Dr. Blomgren does not persuasively explain how the carbonized binder, which he speculates provides the electrical connections required for the increased specific capacity seen in the Gao Thesis electrode at 670 °C, could withstand the swelling and contraction of the silicon nanowires during the charge/discharge cycle and allow for the reversible capacities reported in the Gao Thesis.

Based on the foregoing, we credit the testimony of Drs. Zhou and van Schalkwijk and find that at least some of the silicon nanowires in the electrode of the Gao Thesis crossed over one another to form a porous structure with silicon-to-silicon intersections. We also find Petitioner's identifications as to where the Gao Thesis discloses the remaining limitations of claim 1 reasonable and supported by both the express disclosures of the reference and the testimony of Drs. Zhou and van Schalkwijck; therefore, we adopt them as our own for purposes of this Decision. Pet. 17–25. Accordingly, Petitioner has demonstrated by a preponderance of the evidence that claim 1 is anticipated by the Gao Thesis.

b. Claims 3, 11, and 13

Patent Owner contends claims 3, 11, and 13 rise or fall with claim 1. Tr. 50:18–19. For the reasons discussed above, we are persuaded that the Gao Thesis anticipates claim 1.[10] Thus, claims 3, 11, and 13 fall with claim 1.

Moreover, we have reviewed the evidence of record and find that Petitioner has identified sufficiently: where the Gao Thesis discloses the limitations of claim 3; where the subject matter of claim 11 is disclosed in

---

[10] As further discussed below, we also find that subject matter of claim 1 would have been obvious over the Zhou Patent and Zhou Article.

the Gao Thesis and Zhou Patent or the Zhou Patent and Zhou Article; and where the subject matter of claim 13 is disclosed in the Gao Thesis and Winter or the Zhou Patent, Zhou Article, and Winter. Pet. 26 (citing Ex. 1012, 106–107; Ex. 1003 ¶ 127), 31–35, 52–53, 57–58. Petitioner also provides reasoned explanations as to why one of ordinary skill in the art would have sought to combine the teachings of the recited references to arrive at the subject matter of claims 11 and 13. Pet. 29–30, 32, 54–57. Thus, Petitioner has demonstrated by a preponderance of the evidence that claims 3, 11, and 13 are unpatentable.

c. Claim 7

Claim 7 depends from claim 1 and further requires that "the mass of silicon in the electrically interconnected mass is 70 to 95 percent." Ex. 1001, 6:6–8.

Petitioner contends that, because the electrode of the Gao Thesis utilizes 10 wt. % binder and carbon black, 90% of the electrode mass must consist of the interconnected silicon nanowires. Pet. 27 (citing Ex. 1003 ¶ 131). Thus, Petitioner asserts that claim 7 is anticipated by the Gao Thesis. *Id.*

Patent Owner contends the silicon nanomaterial of the Gao Thesis is a 2:1 mixture of nanowires and nanoparticles, with the nanoparticles consisting largely of iron disilicide. PO Resp. 28–29. Patent Owner further contends that the silicon material in the Gao Thesis is "estimated to have 10% by weight of oxygen." *Id.* at 29 (citing Ex. 1012, 104; Ex. 2001 ¶ 44). Subtracting not only the PVDF binder and carbon black content, but also the oxygen and iron content in the electrode, Patent Owner calculates that "only

67.5% by weight of the interconnected mass of the anode" in the Gao Thesis is silicon. *Id.* at 29–30 (citing Ex. 2001 ¶ 45).

Petitioner does not address claim 7 in its Reply, but noted during oral argument that the oxide layer in the Gao Thesis could be removed, which would alter the calculation for the mass of silicon in the electrode. Tr. 56:14–22 (citing Ex. 2001 ¶ 38).

As noted by Patent Owner, the Gao Thesis discloses that the "[t]he average oxygen concentration in nanostructured Si (n-Si) was estimated to be 10 wt. %." Ex. 1012, 104. Taking into account this oxygen content, as well as the presence of iron disilicide nanoparticles in the Gao Thesis electrode, Dr. Blomgren persuasively testifies that the mass of silicon in the electrode was below the level recited in claim 7 of the '831 patent. Ex. 2001 ¶ 45. Petitioner provides no calculations or persuasive evidence to rebut Dr. Blomgren's testimony. Tr. 56:14–22. Thus, Petitioner has not demonstrated by a preponderance of the evidence that claim 7 is anticipated by the Gao Thesis.

d. Claim 8

Claim 8 depends from claim 1 and further requires that "the intersections comprise a disrupted crystalline or amorphous structure." Ex. 1001, 6:10–12.

Petitioner contends the polycrystalline silicon nanowires of the Gao Thesis electrode form "at least some" intersections and were converted to disrupted silicon after the first charge/discharge cycle. Pet. 27–28 (citing Ex. 1012, 106, 109). This argument is supported by the testimony of Dr. Zhou, who notes that "[d]uring the first lithiation cycle, the crystalline structure of the nano-Si phase disappeared completely, indicating the full lithiation of the silicon nanowires and silicon nano-particles and the transition to amorphous phase." Ex. 1004 ¶ 18 (citing Ex. 1010, Fig. 2b).

Patent Owner contends claim 8 is not anticipated by the Gao Thesis, because there is insufficient evidence that there are "intersections" between silicon nanowires in the electrode, as required by claim 1 from which claim 8 depends. PO Resp. 31–32.

For the reasons discussed above, Petitioner has demonstrated that "at least some" of the nanowires in the disclosed electrode overlap and form "intersections." Petitioner also provides persuasive evidence that all of the crystalline structure of the nanowires was converted to an amorphous phase during the first lithiation cycle. Pet. 27–28; Ex. 1004 ¶¶ 18–19. Thus, we find that claim 8 is anticipated by the Gao Thesis.

D. Gao Thesis and Li – Claims 20, 23, and 25

Petitioner contends the subject matter of claims 20, 23, and 25 of the '831 patent would have been obvious over the Gao Thesis and Li. Pet. 39–43.

1. Li

Li is directed to the crystal structure of silicon particles and nanowires after lithium insertion/extraction. Ex. 1008, Abstract. Li reports that "insertion of lithium ions destroys the crystal structure of [silicon]," leading to the formation of metastable amorphous Li–Si alloy. *Id.* at 185. Li further reports that nanosized silicon particles and wires were found to have "merged together after the insertion/extraction of lithium ions." *Id.* at Abstract.

2. Analysis—Claim 20

Claim 20 is similar in scope to claim 1, but requires that the "intersections comprise a disrupted crystalline or amorphous structure which welds the elongated structures to one another." Ex. 1001, 6:49–57.

Petitioner identifies where the Gao Thesis expressly or inherently discloses every limitation of claim 20. Pet. 39–42. With respect to "welds," Petitioner contends one of ordinary skill in the art would have understood that welding of nanowires during cycling was a "well-known phenomenon" and that the lithium insertion/extraction process set forth in the Gao Thesis, which caused the silicon nanowires to transition from disrupted crystalline to an amorphous silicon phase, would result in the welding of intersecting silicon nanowires, as disclosed in Li. *Id.* at 41–42 (citing Ex. 1003 ¶¶ 117–120); Pet. Reply 18–19 (citing Ex. 1003 ¶¶ 71–72).

Patent Owner contends claim 20 is not anticipated by the Gao Thesis because the PVDF binder prevents intersections between the silicon nanowires. PO Resp. 33. Patent Owner further contends that, because Li does not use the same high temperature annealing step as set forth in the Gao Thesis, it is "unclear" whether the anode structure of the Gao Thesis "is in fact sufficiently similar to the structure of the anode of Li that Li's conclusion should apply thereto." *Id.* at 33–35 (citing Ex. 2001 ¶ 57).

As noted above, Petitioner has demonstrated that at least some of the silicon nanowires of the Gao Thesis electrode formed silicon-to-silicon intersections. Dr. Zhou also persuasively testifies that during the first lithiation cycle, "the crystalline structure of the nano-Si phase disappeared completely." Ex. 1004 ¶ 18. Given the evidence of intersections and complete lithiation of the silicon nanowires in the Gao Thesis electrode, we find Petitioner's argument persuasive that at least some of the silicon nanowires of the Gao Thesis electrode formed "welds." Pet. 39–42; Pet. Reply 18–19 (noting that the process of transitioning from crystalline to amorphous silicon phases during cycling "is precisely the same mechanism the '831 patent and Dr. Blomgren claim results in 'welding'") (citing Ex. 1001, 5:21–28; Ex. 2001 ¶¶ 17, 19). Thus, Petitioner has demonstrated a by a preponderance of the evidence that the subject matter of claim 20 would have been obvious over the Gao Thesis and Li. *See Connell v. Sears, Roebuck & Co.*, 722 F.2d 1542, 1548 (Fed. Cir. 1983) ("[A] disclosure that anticipates under § 102 also renders the claim invalid under § 103, for 'anticipation is the epitome of obviousness.'") (quoting *In re Fracalossi*, 681 F.2d 792 (CCPA 1982)).

3. Analysis—Claims 23 and 25

Patent Owner concedes that claims 23 and 25 stand or fall with claim 20. Tr. 50:19–20. Thus, given our determination that claim 20 would have been obvious over the Gao Thesis and Li, we determine that the subject matter of claim 23 and 25 likewise would have been obvious over that same set of references.

E. Obviousness of Claims 1, 3, 7, and 8 over Zhou Patent and Zhou Article

Petitioner contends the subject matter of claims 1, 3, 7, and 8 would have been obvious over the Zhou Patent and Zhou Article. Pet. 45–53. In support, Petitioner identifies where every limitation of these claims is disclosed, expressly or inherently, in the Zhou Patent and the Zhou Article. *Id.* Petitioner also contends that one of ordinary skill in the art would have sought to combine the disclosures of these two references because they involve the same key inventors/authors and "are based on the same research project" described in the Gao Thesis *Id.* at 46–47; *see also* PO Resp. 3 ("As noted by Petitioner, the Gao Thesis, the Zhou Article and the Zhou Patent (collectively, the 'Gao References'), all relate to the same research project, performed by the same people, over the same period of time. Accordingly, Patent Owner treats these references as a unified body of work.") (internal citations omitted).

Patent Owner does not contest that one of ordinary skill in the art would have sought to combine the disclosures of the Zhou Patent and Zhou Article, but contends these references fail to render claims 1, 3, 7, and 8 obvious for the same reasons set forth above with respect to Petitioner's anticipation ground based on the Gao Thesis. PO Resp. 3–4 (Patent Owner treating the Gao Thesis, Zhou Patent, and Zhou Article "as a unified body of work"), 16 (noting that the argument that the Gao Thesis anticipates claim 1 is "essentially identical in substance" to the argument that claim 1 would have been obvious over the Zhou Patent and Zhou article), 30, 32. In particular, Patent Owner contends that the Zhou Patent and Zhou article do not disclose, expressly or inherently, an electrode that is porous and has elongated structures that form intersections. *Id.* at 16–32.

Patent Owner's argument that the Zhou Patent and Zhou Article do not demonstrate that the silicon nanowire electrode was porous or contained intersections is based on the same evidence and reasoning as discussed above with respect to the Gao Thesis. Accordingly, we credit the testimony of Drs. Zhou and van Schalkwijk discussed above, and find that the combination of the Zhou Patent and Zhou Article teaches or suggests a silicon nanowire electrode having both a porous structure and silicon-to-silicon intersections. And, because they are reasonable and supported by record evidence, we adopt Petitioner's identifications as to where the Zhou Patent and Zhou Article disclose the remaining limitations of claims 1, 3, and 8 of the '831 patent. Pet. 45–53; PO Resp. 27 (conceding that the patentability of claim 3 rises or falls with that of claim 1). We also find persuasive Petitioner's argument that one of ordinary skill in the art would have sought to combine the disclosures of the Zhou Patent and Zhou Article, as these references are directed to the same research project. Pet. 46–47 (citing Ex. 1004 ¶ 6). Thus, Petitioner has demonstrated by a preponderance of the evidence that the subject matter of claims 1, 3, and 8 would have been obvious over the Zhou Patent and Zhou Article.

With respect to claim 7, however, Petitioner relies upon the same 90:5:5 ratio of silicon nanowires, carbon black, and binder that we found unpersuasive with respect to anticipation by the Gao Thesis. Pet. 52. Thus, for the reasons discussed above, we find that Petitioner has not demonstrated by a preponderance of the evidence that the subject matter of claim 7 would have been obvious over the Zhou Patent and Zhou Article.

III. ORDER

It is hereby:

ORDERED that Petitioner has demonstrated by a preponderance of the evidence that claims 1, 3, 8, 11, 13, 20, 23, and 25 of the '831 patent are unpatentable;

FURTHER ORDERED that Petitioner has not demonstrated by a preponderance of the evidence that claim 7 is unpatentable; and

FURTHER ORDERED that, because this is a Final Written Decision, parties to the proceeding seeking judicial review of the Decision must comply with the notice and service requirements of 37 C.F.R. § 90.2.

PETITIONER:

Jennifer Hayes
NIXON PEABODY, LLP
jenhayes@nixonpeabody.com

PATENT OWNER:
Richard Carden
James Suggs
MCDONNELL, BOEHNEN, HULBERT, AND BERGHOFF, LLP
carden@mbhb.com
suggs@mbhb.com

Trials@uspto.gov
Tel. 571-272-7822

Paper 17
Entered: July 31, 2017

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

ONED MATERIAL LLC,
Petitioner,

v.

NEXEON LIMITED,
Patent Owner.

Case IPR2016-01528
Patent 8,597,831 B2

Before BRIAN P. MURPHY and JON B. TORNQUIST,
Administrative Patent Judges.

MURPHY, *Administrative Patent Judge*.

ORDER
Conduct of the Proceeding
37 C.F.R. § 42.5

On July 28, 2017, Counsel for Nexeon Limited ("Patent Owner") sent an email requesting a conference call with the Board. Patent Owner wanted to discuss Patent Owner's request to depose Dr. Walter van Schalkwijk, an expert who provided a declaration in support of the Petition filed by OneD Material LLC ("Petitioner"). The email indicated the parties had discussed the issue but were unable to reach an agreement, and that Petitioner objected to the proposed deposition as untimely. A conference call was convened by Judges Murphy and Tornquist the afternoon of July 28th, with Ms. Jennifer Hayes representing Petitioner and Mr. Richard Carden representing Patent Owner.

By way of background, Petitioner filed Dr. van Schalkwijk's Corrected Declaration in support of the Petition challenging certain claims of U.S. Patent No. 8,597,831 B2 ("the '831 patent"), on November 2, 2016. Paper 8; Ex. 1003.[1] Patent Owner chose not to depose Dr. van Schalkwijk prior to filing its Response to the Petition on April 14, 2017. Petitioner filed its Reply on June 28, 2017. Petitioner did not file a supplemental declaration of Dr. van Schalkwijk in support of its Reply.

During the conference call, Patent Owner asserted that Petitioner had raised some new arguments and relied on new evidence in the Reply. Patent Owner contended that Petitioner's Reply, for the first time, discusses the impact high temperature annealing of PVDF binder has on intersecting silicon nanowires in an electrochemical anode. Patent Owner also contended that Petitioner's Reply contains new arguments and evidence regarding the use of methanol as a solvent when fabricating silicon nanowire

[1] Petitioner initially filed the Corrected Declaration as Paper 9, but it was later expunged and refiled as Exhibit 1003 on January 19, 2017.

electrodes. Patent Owner argued that because the Reply contains new arguments and evidence, and because Patent Owner had not previously deposed Dr. van Schalkwijk, Patent Owner should be authorized to cross-examine Dr. van Schalkwijk with respect to the alleged new Reply arguments.

Petitioner argued that, under the circumstances, it was improper for Patent Owner to cross-examine Dr. van Schalkwijk. Petitioner argued that the Reply does not cite or rely on Dr. van Schalkwijk's Corrected Declaration testimony regarding the alleged new arguments. The Reply contains two substantive citations to Dr. van Schalkwijk's Corrected Declaration. The first relates to the parties' dispute over whether the Gao Thesis (Ex. 1012) discloses the concept of "welding" at the intersections of silicon nanowires as described in the '831 patent. Reply 18–19 (citing Ex. 1003 ¶¶ 70–72). The second relates to whether the Li Article (Ex. 1008) discloses the welding concept. *Id.* at 19 (citing Ex. 1003 ¶¶ 117–119). Petitioner further argued that the Reply directly responds to the arguments made in Patent Owner's Response and the supporting declaration testimony of Patent Owner's expert, Dr. George Blomgren. A further review of the Reply indicates that it is primarily a rebuttal of Dr. Blomgren's Declaration testimony (Ex. 2001) and relies heavily on the deposition testimony of Dr. Blomgren (Ex. 1030) in support of such rebuttal. Reply 8–18.

After discussion with the parties, we denied Patent Owner's request to cross-examine Dr. van Schalkwijk, but authorized Patent Owner to file a Sur-Reply not to exceed seven pages in length and limited to the alleged new arguments and evidence raised in the Reply. We also stated that if Patent Owner chose to file a further declaration of Dr. Blomgren in support of its Sur-Reply, then Dr. Blomgren would be subject to cross-examination by

Petitioner. We ordered Patent Owner to consider our ruling and contact Petitioner to work out appropriate dates for filing the Sur-Reply and any deposition of Dr. Blomgren that might be necessary, along with Petitioner's Observations on any such deposition testimony.

ORDER

Accordingly, it is

ORDERED that Patent Owner's request for authorization to depose Dr. Walter van Schalkwijk is denied;

FURTHER ORDERED that Patent Owner is authorized to file a Sur-Reply not to exceed seven pages, limited to addressing the alleged new arguments and evidence in the Reply. Patent Owner may support the Sur-Reply with a supplemental declaration of Dr. Blomgren;

FURTHER ORDERED that the parties shall meet and confer to agree to a schedule for filing the Sur-Reply and deposing Dr. Blomgren, if necessary, along with time for Petitioner to file Observations on Dr. Blomgren's deposition testimony;

FURTHER ORDERED that the parties may not reschedule Due Dates 6 and 7 in the Scheduling Order without prior authorization of the Board; and

FURTHER ORDERED that the parties will promptly file a stipulation containing the agreed dates for filing the Sur-Reply and any Observations on Dr. Blomgren's deposition testimony that may be necessary.

FOR PETITIONER:

Jennifer Hayes
NIXON PEABODY LLP
jenhayes@nixonpeabody.com

FOR PATENT OWNER:

Richard Carden
James Suggs
McDonnell Boehnen Hulbert & Berghoff LLP
carden@mbhb.com
suggs@mbhb.com