

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

ONED MATERIAL LLC,
Petitioner,

v.

NEXEON LIMITED,
Patent Owner.

Case IPR2017-00961
Patent 8,940,437 B2

Before BRIAN P. MURPHY, JON B. TORNQUIST, and
CHRISTOPHER M. KAISER, *Administrative Patent Judges*.

TORNQUIST, *Administrative Patent Judge*.

DECISION
Denying Institution of *Inter Partes* Review
37 C.F.R. § 42.108

I. INTRODUCTION

OneD Material LLC (“Petitioner”) filed a Petition (Paper 4, “Pet.”) requesting *inter partes* review of claims 18–23 of U.S. Patent No. 8,940,437 B2 (Ex. 1001, “the ’437 patent”). Nexeon Limited (“Patent Owner”) filed a Preliminary Response to the Petition (Paper 11, “Prelim. Resp.”).

We have authority to determine whether to institute an *inter partes* review. 35 U.S.C. § 314; 37 C.F.R. § 42.4(a). The standard for instituting an *inter partes* review is set forth in 35 U.S.C. § 314(a), which provides that an *inter partes* review may not be instituted “unless the Director determines . . . there is a reasonable likelihood that the petitioner would prevail with respect to at least 1 of the claims challenged in the petition.”

After considering the Petition and the Preliminary Response, we determine that Petitioner has not demonstrated a reasonable likelihood of prevailing with respect to claims 18–23 of the ’437 patent. Accordingly, we do not institute *inter partes* review.

A. Related Proceedings

The parties indicate that the ’437 patent and U.S. Patent No. 8,597,831 (“the ’831 patent”) are at issue in *Nexeon Limited v. EaglePicher Technologies, LLC and OneD Material LLC.*, Case No. 1:15-cv-00995-RGA (D. Del.). Pet. 2; Paper 6, 2. The parties further note that the ’831 patent is at issue in IPR2016–01528. Pet. 2; Paper 6, 2.

B. The ’437 Patent

The ’437 patent discloses pillared silicon particles and a method of fabricating the same. Ex. 1001, Abstract. The ’437 patent notes that in conventional lithium–ion rechargeable battery cells, graphite is used as an anode. *Id.* at 1:33–36. When the battery containing the graphite anode is

charged, lithium reacts with the graphite to form LiC_6 , which “has a maximum capacity of 372 mAh/g.” *Id.* at 1:55–60. In contrast to conventional graphitic anodes, a silicon anode will react with lithium to form $\text{Li}_{21}\text{Si}_5$, which has a maximum capacity of 4,200 mAh/g. *Id.* at 1:63–2:5. Silicon anodes swell considerably during the charge/discharge cycle, however, causing the anodes to crack or disintegrate. *Id.* at 2:6–10, 2:18–26, 2:32–41.

The ’437 patent explains that one approach known in the art to overcome the problem of volumetric swelling was the use of nano-scale silicon powders. *Id.* at 2:11–52. Although these powders are not destroyed during the expansion process, the individual powder particles become isolated from one another and from the copper current collector during the charge/discharge cycle, again resulting in limited sustained capacity. *Id.* According to the ’437 patent, these problems have “prevented silicon particles from becoming a commercially viable replacement for graphite in lithium rechargeable batteries.” *Id.* at 2:48–52.

Another approach for overcoming volumetric expansion in silicon anodes is the use of a silicon electrode fabricated with a regular or irregular array of silicon pillars. *Id.* at 3:21–34. These silicon pillars are able to absorb the volumetric expansion/contraction associated with the charge and discharge cycles, but the pillars are produced on a high purity, single-crystal silicon wafer, which is expensive. *Id.* at 3:24–34.

To overcome the volumetric expansion problems of prior art silicon powders, and to reduce the cost of silicon anodes, the ’437 patent discloses a method of forming silicon pillars on the surface of silicon powders. *Id.* at 3:35–56. These pillared particles may be arranged in a composite structure

(particles, polymer binder, and a conductive additive) or may be directly bonded to the current collector. *Id.* at 4:35–51. According to the '437 patent, “[t]he structure of the particles overcomes the problems of charge/discharge capacity loss.” *Id.* at Abstract.

C. Illustrative Claims

Claims 18 and 20 are illustrative of the challenged claims and are reproduced below:

18. A plurality of discrete particles wherein each particle comprises silicon and includes a particle core and a plurality of silicon-comprising pillars fabricated on the particle core and extending outwardly therefrom from a first end to a second end, wherein each pillar in the plurality of pillars is attached to the core at the first end of the pillar, and the second end of each pillar is an unattached free end, wherein in each particle, the fraction of the surface area of the particle core occupied by the pillars is in the range of 0.10 to 0.50.

Ex. 1001, 10:20–28.

20. A composite electrode for a lithium-ion battery comprising a plurality of discrete particles as claimed in claim 18 and further comprising at least one of a conductive additive and a binder.

Id. at 10:32–35.

D. The Asserted Grounds of Unpatentability

Petitioner contends claims 18–23 of the '437 patent are unpatentable based on the following grounds (Pet. 14–43):¹

¹ Petitioner also relies on a declaration from Dr. Kurt W. Kolasinski (Ex. 1051).

References	Basis	Claims Challenged
Farrell, ² Peng, ³ and Green, ⁴ in view of the knowledge of a person of ordinary skill in the art, as evidenced by Kolasinski ⁵ and Kasavajjula ⁶ .	§ 103	18–23
Farrell, Peng, Green, and Kasavajjula, in view of the knowledge of a person of ordinary skill in the art, as evidenced by Kolasinski.	§ 103	20 and 23

Petitioner contends that Farrell and Kasavajjula are prior art to the '437 patent under 35 U.S.C. §102(a) and Green, Peng, and Kolasinski are prior art under § 102(b). Pet. 4–5 (asserting that Peng was published online on August 18, 2005). Patent Owner does not challenge the prior art status of any of the asserted references in the Preliminary Response.

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

² WO 2007/037787, filed May 5, 2006 and published April 5, 2007 (Ex. 1004).

³ Peng, K., et al., *Aligned Single–Crystalline Si Nanowire Arrays for Photovoltaic Applications*, 1 SMALL Vol. 11, 2005, pp. 1062–1067 (Ex. 1005).

⁴ U.S. Patent Pub. No. 2006/0097691, published May 11, 2006 (Ex. 1006)

⁵ Kolasinski, K., *Silicon Nanostructures from Electroless Electrochemical Etching*, 9 CURRENT OPINION IN SOLID STATE AND MATERIALS SCIENCE, 2005, pp. 73–83 (Ex. 1007).

⁶ Kasavajjula, U., et. al., *Nano– and Bulk–Silicon–Based Insertion Anodes for Lithium–Ion Secondary Cells*, 163 JOURNAL OF POWER SOURCES, 2007, pp. 1003–1039 (Ex. 1008).

patent in which it appears.” 37 C.F.R. § 42.100(b); *Cuozzo Speed Techs., LLC v. Lee*, 136 S. Ct. 2131, 2144–46 (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, 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).

Petitioner and Patent Owner dispute the proper construction of the term “first dimension.” Pet. 13–14; Prelim. Resp. 24 n.6. Because the current Decision does not depend on the proper construction of the term “first dimension,” and because the parties do not dispute the construction of any other claim terms, we determine that no claim terms require construction for purposes of this Decision. *See Vivid Techs., Inc. v. Am. Sci. & Eng’g, Inc.*, 200 F.3d 795, 803 (Fed. Cir. 1999) (“only those terms need be construed that are in controversy, and only to the extent necessary to resolve the controversy”).

B. Alleged Obviousness of Claims 18–23 over Farrell, Peng, and Green, in view of Kolasinski and Kasavajjula

Petitioner contends the subject matter of claims 18–23 would have been obvious over Farrell, Peng, and Green, in view of the knowledge of one of ordinary skill in the art, as evidenced by Kolasinski and Kasavajjula. Pet. 14–40.

1. *Farrell*

Farrell discloses “porous silicon particles prepared from a metallurgical grade silicon powder.” Ex. 1004, 1:10–11.⁷ Farrell indicates that these porous particles are useful “as carrier materials for a broad range of applications such as catalysts and drugs, adsorbents, sensors, explosives, photosensitizers, precursors for high surface area forms of ceramics such as SiC and Si₃N₄, and as electrodes in fuel cells.” *Id.* at 3:24–27.

Farrell explains that previous methods of producing porous silicon particles provided low yields and were difficult to scale up for large diameter wafers. *Id.* at 1:27–32. Thus, according to Farrell, there existed in the art “a need for a low cost and reliable production method capable of producing large quantities of porous silicon.” *Id.* at 2:1–6.

Farrell notes that Li et al. previously disclosed a method for stain etching individual silicon powder particles and subjecting the resulting porous particles to ultrasonic agitation to yield individual silicon nanoparticles. *Id.* at 2:7–12. According to Farrell, one advantage of this method is that it allows the use of powders instead of single crystalline silicon wafers, thereby “enabling etching of a much higher surface area per gram of the material.” *Id.* at 2:12–14. Li’s technique, however, is limited to silicon particles having a porosity with a “maximum thickness of only 500 nm (0.5 microns).” *Id.* at 3:1–4.

To overcome the porosity limitations of Li, Farrell discloses isolating silicon particles having a size greater than about 1 microns and etching these particles to yield porous silicon particles having a “solid core surrounded by

⁷ Citations to Farrell are to the original page numbers provided in the document.

a porous silicon layer having a thickness greater than about 0.5 microns.” *Id.* at 3:19–24. Farrell reports that “any etching method known to one of ordinary skill in the art may be employed” in the disclosed process, but a preferred method is stain etching with a solution comprising HF:HNO₃:H₂O at a ratio ranging from about 4:1:20 to about 2:1:10 by weight. *Id.* at 7:3–5, 7:13–15.

2. Peng

Peng discloses the formation of one dimensional silicon nanowires (SiNWs) that can be “readily prepared on single-crystal Si substrates.” Ex. 1005, 1063. Figure 1a of Peng, reproduced below, is an image of a SiNW array:

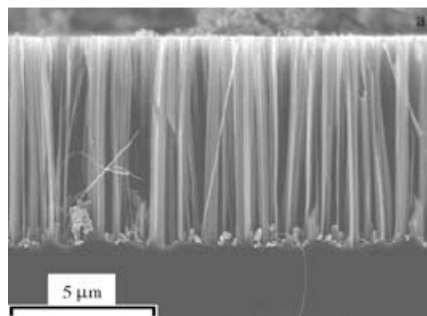


Figure 1a is a scanning electron microscope cross-section image of a silicon nanowire array

According to Peng, production of SiNW arrays “is quite simple” and involves cleaning silicon wafers and immersing the cleaned wafers “into a HF-based aqueous solution containing silver nitrate in sealed vessels” for a desired amount of time. *Id.* Peng reports that the length of the SiNWs can be effectively controlled by tuning the treatment time, and that “the orientations of obtained silicon nanowires are always identical with the orientation of initial Si substrates.” *Id.* at 1063–64. Peng further reports that

the disclosed etching methods “can be readily extended to polycrystalline Si substrates.” *Id.* at 1064.

3. Green

Green discloses structured silicon anodes for lithium battery applications. Ex. 1006 ¶ 1. In particular, Green is directed to “a lithium battery integrated on to a silicon chip.” *Id.* ¶ 3, Abstract.

Green notes that “[s]ilicon is recognized as a potentially high energy per unit volume host material for lithium battery applications.” *Id.* ¶ 2. Green further notes that, due to the significant volume change caused by the formation of $\text{Li}_{12}\text{Si}_7$ in lithium battery applications, conventional silicon wafers tend to crack and pulverize during the charge/discharge cycle. *Id.* ¶¶ 2, 6. To overcome this problem, Green discloses “a method of fabricating sub-micron silicon electrode structures on a silicon wafer,” preferably in the form of “pillars.” *Id.* ¶ 4.

To form the disclosed pillar structures, Green applies “Island Lithography.” *Id.* ¶ 22. In this method, cesium chloride (CsCl) is vacuum deposited on the surface of the Si substrate and exposed to the atmosphere at a controlled relative humidity. *Id.* As water adsorbs on the surface, the CsCl re-organizes into a distribution of hemispherical islands that act as “X masks” during ion etching, resulting in the formation of pillar structures. *Id.* Green explains that “[a]n appropriate size restriction to achieve suitable electrodes is that the silicon pillars should not exceed a fractional surface coverage (F) of ~ 0.5 .” *Id.* ¶ 6.

Green notes that “[i]n order to obtain charging rates suitable for various applications it is necessary to increase the surface area of the Si/electrolyte interface.” *Id.* ¶ 19. “Previous attempts using silicon particles

have failed,” according to Green, “because the particle-to-particle contacts change and part with cycling.” *Id.* The disclosed pillared silicon wafers “on the other hand, are largely maintained” during the charge/discharge cycle, “as evidenced by the flatness of the pillar tops after 50 cycles.” *Id.* ¶¶ 6, 19.

4. *Kolasinski*

Kolasinski is a review article that discusses methods for producing silicon nanostructures using various electroless etching methods, including stain etching, metal-assisted etching, and chemical vapor etching. Ex. 1007, Abstract. Kolasinski notes that porous silicon (por-Si) is the most intensively studied variant of nanocrystalline silicon and can be produced simply via electroless etching of silicon substrates. *Id.* at 74. According to Kolasinski, this process “requires the attachment of no electrodes and can be performed on objects of arbitrary shape and size.” *Id.* at 74.

5. *Kasavajjula*

Kasavajjula presents a “review of methodologies adopted for reducing the capacity fade observed in silicon-based anodes.” Ex. 1008, Abstract. Kasavajjula also discusses the “challenges that remain in using silicon and silicon-based anodes” and proposes “possible approaches for overcoming them.” *Id.*

Kasavajjula notes that during cycling, up to a 400% volume expansion of the silicon lattice occurs, resulting in “cracking and disintegration of the electrode.” *Id.* at 1005. “To overcome the large volume change and thus obtain better capacity retention and cycle life for Si anodes,” Kasavajjula notes that several approaches have been suggested in art, including the use of micro– and nano–scale powder anodes. *Id.* Kasavajjula explains, however, that when particle size was reduced to micrometer levels, “no

particular improvement in electrochemical performance was observed.” *Id.* at 1006. According to Kasavajjula, this was due to “poor cycling performance” caused by the “breakdown” of the conductive network during volumetric expansion. *Id.*

Kasavajjula identifies three known techniques for improving the performance of powdered silicon anodes. First, conductive additives, such as “graphite flakes and/or nano-scale carbon black,” can be included within the micro-Si anodes “to improve electronic contact between particles during insertion and extraction.” *Id.* at 1007. Second, the cycling voltage window may be narrowed. *Id.* Third, silicon particle size can be further reduced to nano-scale, thereby resulting in “smaller volume expansion due to reduced particle size.” *Id.*

6. Analysis

Petitioner contends independent claims 18 and 21 of the ’437 patent would have been obvious over the combination of Farrell, Peng, and Green, in view of Kolasinski and Kasavajjula. Pet. 14–39. According to Petitioner, Farrell discloses both etching a metallurgical grade silicon powder to form porous silicon particles and that “any etching method known to one of ordinary skill in the art may be employed” to form the porous particles; Peng discloses forming pillars on a silicon substrate (wafer) using metal-assisted etching; Kolasinski teaches performing electroless etching “on objects of arbitrary shape and size”; and Green discloses forming pillars on a wafer that do not exceed a fractional surface coverage of ~ 0.5 . *Id.*

Petitioner contends a person of ordinary skill in the art would use the etching technique described in Peng to form pillars on Farrell’s particle core because Farrell’s metallurgical powders are “more cost-effective than the

pure silicon wafers and powders known in the art” and because Peng’s metal assisted etching technique is a well-known and “cost-effective fabrication method.” *Id.* at 20, 32. In support of this argument, Dr. Kolasinski testifies that “it would be a simple substitution to replace the polycrystalline wafer etched in Peng with the polycrystalline particles (or powders) etched in Farrell.” Ex. 1051 ¶ 168.

We are not persuaded by Petitioner’s argument. Farrell already provides a metallurgical grade powder. Thus, it is not evident why the general cost of metallurgical grade powders would have caused the ordinary artisan to pillar Farrell’s porous silicon particles using the technique of Peng. Moreover, Petitioner does not explain persuasively why pillared particles would otherwise be desirable in the applications identified in Farrell, or *how* Farrell’s particles could substitute for Peng’s expensive pillared silicon wafers in Peng’s photovoltaic applications. See Ex. 1005, 1064 (noting that the disclosed “SiNW arrays give promising results for possible applications in high-efficiency solar-cell manufacture”), 1066 (“The most interesting feature of the as-synthesized SiNW arrays is the significant suppression of reflection over the visible-light spectral range.”); Prelim. Resp. 21 (noting that Farrell’s materials are not “lithium-ion battery anode materials”); see also *In re Gordon*, 733 F.2d 900, 902 (Fed. Cir. 1984) (noting that a proposed modification must not render a device unsuitable for its intended purpose). Thus, on this record, Petitioner has not explained sufficiently why cost concerns would have caused one of ordinary skill in the art to pillar Farrell’s particles using the metal–assisted etching technique of Peng.

Petitioner also contends that a person of ordinary skill in the art would have sought to combine Farrell and Peng, “because they are both directed to

the formation of pores and pillars (formed via etching pores further) using similar, known techniques for similar applications and using known materials.” Pet. 21, 33 (citing Ex. 1051 ¶¶ 136, 140, 153, 156–160). Farrell is directed to “carrier materials” for use in, among other things, “fuel cells” and Peng is directed to photovoltaic applications. Ex. 1004, 3:24–27; Ex. 1005, 1062. Petitioner does not explain sufficiently why these applications are “similar.” Nor does Petitioner explain sufficiently why any alleged similarities in application between the two references would have caused one of ordinary skill in the art to apply Peng’s pillaring method to Farrell’s porous particles. Thus, on this record, we do not find Petitioner’s argument persuasive.

In support of the proposed combination, Dr. Kolasinski testifies that one of ordinary skill in the art, “for example from reading Kolasinski (Ex. 1007),” would readily recognize “that porous silicon is of great interest in energy storage application[s] such as lithium batteries,” and would have sought to exchange Green’s “expensive” pillared silicon wafers for the pillared silicon powders of Farrell and Peng, in order to reduce costs. Ex. 1051 ¶ 168. Petitioner also contends that one of ordinary skill in the art would have sought to control the fraction of surface area occupied by the pillars of Farrell and Peng to within 0.1 to 0.5 as disclosed in Green, because this fraction range “would improve the ability of electrodes incorporating the particles to tolerate the volume changes associated with lithium alloying and dealloying.” Pet. 26, 38.

As noted above, evidence that a modification would be cost-effective is irrelevant if the modified device cannot achieve its intended purpose. Here, Green’s “invention” seeks to incorporate a lithium battery “on to a

silicon chip,” Ex. 1006 ¶¶ 3–4, and neither Petitioner nor Dr. Kolasinski present credible evidence that the pillared particles of Farrell and Peng could accomplish this goal. Thus, on this record, Petitioner has not explained sufficiently why one of ordinary skill in the art would have sought to combine the relevant disclosures of Farrell, Peng, and Green (as further evidenced by Kolasinski and Kasavajjula) to arrive at the subject matter of claim 18.

To the extent Petitioner asserts that an ordinary artisan would have sought generally to use porous particles in lithium-ion anodes, and that such an ordinary artisan would have then sought to modify such porous particles to add pillars in order to “tolerate the volume changes associated with lithium alloying and dealloying” (Pet. 26), Green acknowledges that silicon powder anodes were known in the prior art, but notes that “[p]revious attempts using silicon particles have failed because the particle-to-particle contacts change and part with cycling.” Ex. 1006 ¶ 19. Tellingly, despite disclosing the use of pillars to overcome cracking of the wafer due to volumetric expansion, and despite disclosing the problem of failed particle-to-particle contacts within powdered lithium-ion anodes, we are directed to no persuasive disclosure in Green, or in the other references recited in Petitioner’s asserted Ground, that pillars formed on *discrete particles* could overcome the change in particle-to-particle contacts induced during the charge/discharge cycle within powdered silicon anodes.⁸ *Id.* ¶¶ 2

⁸ Dr. Kolasinski identifies two references (Exs. 1009 and 1010) which he asserts describe Green’s publication (Ex. 1021) as disclosing pillared particles. Ex. 1051 ¶¶ 89–91. Although one reference does disclose that nanopillar surface morphology alters “particle deformation and reduces fracturing,” as noted by Patent Owner it is not evident that either reference

(“[m]etallic and intermetallic anodic host materials . . . are reported to disintegrate after a few lithium insertion/extraction cycles.”), 3–4 (explaining that the invention provides a method for producing pillars on a silicon wafer), 19.

Consistent with Green’s disclosures, Kasavajjula indicates that micro–Si anodes have poor cycling performance “due to breakdown of the electronically conductive network” caused by “large Si volume expansion” during the alloying and de-alloying process. Ex. 1008, 1005–1006. Kasavajjula then goes on to identify three potential methods for improving the performance of powdered Si anodes. *Id.* at 1007. And, despite being aware of Green’s pillaring methods, as well as Green’s disclosure that such pillars allow a silicon *wafer* to withstand volume expansion during the charge/discharge cycle, Kasavajjula does not suggest using pillared *particles* to overcome capacity fade in powdered lithium–ion battery anodes. Indeed, in describing Green’s pillared wafers (as disclosed in Ex. 1021 and U.S. Patent Application 2006/0097691), Kasavajjula notes that “[i]n spite of their reasonable capacity retention, they showed a low faradaic efficiency through 50 cycles, which would limit their practical use.” *Id.* at 1026. Thus,

contemplates pillaring *discrete particles*. Prelim. Resp. 3–6, 13–14; Ex. 1009, 367; Ex. 1010, 90. Indeed, in reviewing Green’s disclosures, Dr. Kolasinski testifies that Green discloses “a nanostructured silicon anode etched on a wafer.” Ex. 1051 ¶ 88. Likewise, Kasavajjula provides a review of Green’s publication and published patent application and describes his method as being directed to the pillaring of “Si films.” Ex. 1008, 1026. Thus, on this record, Petitioner has not demonstrated sufficiently that Exhibits 1009 and 1010 teach or suggest pillaring discrete particles, or that the art of record teaches or suggests the use of pillars to prevent the loss of particle-to-particle contacts within a powdered silicon anode. Prelim. Resp. 13–14.

Kasavajjula tends to support Patent Owner's argument that it would not have been obvious, prior to the earliest filing date of the '437 patent, to use discrete pillared particles in lithium-ion battery anodes.

In light of the foregoing, Petitioner has not demonstrated sufficiently that one of ordinary skill in the art would have sought to combine Farrell and Peng to form a pillared particle. Nor has Petitioner demonstrated sufficiently that if such a particle were formed, one of ordinary skill in the art would have sought to use it in a silicon anode for a lithium-ion battery in view of the disclosures of Farrell, Peng, and Green (as well as the disclosures of Kolasinski and Kasavajjula).⁹ Thus, Petitioner has not demonstrated a reasonable likelihood that independent claims 18 and 21 would have been obvious over Farrell, Peng, and Green, as evidenced by Kolasinski and Kasavajjula.

As dependent claims 19, 20, 22, and 23 each depend from one of claims 18 or 21, Petitioner has also not demonstrated sufficiently that the subject matter of these claims would have been obvious over the recited references.

C. Claims 20 and 23 over Farrell, Peng, and Green, in view of Kasavajjula and Kolasinski

Claims 20 and 23 both require a composite electrode for a lithium-ion battery comprising a plurality of discrete particles and at least one of a conductive additive and a binder. Ex. 1001, 10:33–35, 10:47–50. Petitioner

⁹ Independent claims 18 and 21 are directed to discrete particles, without reference to their intended use. Ex. 1001, 10:20–28, 10:36–44. Petitioner's reasons to combine the asserted references, however, rely upon the use of the particles of Farrell, Peng, and Green in lithium battery applications. Pet. 26.

contends the subject matter of claims 20 and 23 would have been obvious over Farrell, Peng, and Green, in view of Kasavajjula and Kolasinski. Pet. 41–43.

Petitioner asserts that Kasavajjula discloses an electrode for a lithium–ion battery that utilizes both discrete particles (silicon powder) and a conductive additive or binder. Pet. 42–43 (citing Ex. 1008, 1007). Petitioner further asserts that one of ordinary skill in the art would have found it obvious to substitute the silicon powder particles of Kasavajjula with the pillared particles of Farrell, Peng, and Green, because such particles are “cheaper, would reduce fracturing, and [would] increase the surface area to improve the flow of lithium.” *Id.* at 43 (citing Ex. 1051 ¶¶ 36, 89–92, 133, 168, 191–192).

As noted above, Petitioner has not explained sufficiently why one of ordinary skill in the art would have combined the disclosures of Farrell, Peng, and Green to transform Farrell’s porous particles into pillared particles having a fraction of the surface area of the particle core occupied by the pillars in the range of 0.10 to 0.50. Accordingly, Petitioner has not demonstrated sufficiently that one of ordinary skill in the art would have sought to substitute Kasavajjula’s powders with such particles in view of the recited prior art references.

And, as discussed above, despite acknowledging the problem of fracturing and capacity fade in silicon powder anodes due to volumetric expansion, and despite analyzing potential approaches for solving this problem, and despite being aware of Green’s pillaring methods and its disclosure that pillar arrays “may tolerate” volume changes in silicon wafers due to cycling, Kasavajjula does not disclose or suggest using pillared

silicon particles. This contemporary review article therefore tends to support Patent Owner's argument that one of ordinary skill in the art would not have found it obvious to substitute Kasavajjula's silicon powders with pillared particles in view of Farrell, Peng, Green, Kolasinski, and Kasavajjula.

In view of the foregoing, Petitioner has not demonstrated a reasonable likelihood that the subject matter of claims 20 and 23 would have been obvious over Farrell, Peng, Green, Kolasinski, and Kasavajjula.

III. CONCLUSION

Upon consideration of the Petition and the Preliminary Response, we conclude that Petitioner has not demonstrated a reasonable likelihood that claims 18–23 of the '437 patent would have been obvious over the recited prior art. Accordingly, we do not institute *inter partes* review with respect to those claims.

IV. ORDER

It is hereby

ORDERED that *inter partes* review is not instituted.

IPR2017-00961
Patent 8,940,437 B2

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