

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

CANADIAN SOLAR INC.,
Petitioner

v.

MAXEON SOLAR PTE. LTD.,
Patent Owner

Case IPR2024-01038¹
U.S. Patent No. 11,251,315

PATENT OWNER'S SUR-REPLY

¹ IPR2024-01194 has been consolidated with the instant proceeding.

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PATENT OWNER'S EXHIBIT LIST

Exhibit	Description
2001	Declaration of David Carroll, Ph.D. in Support of Patent Owner Preliminary Response
2002	<i>Intentionally Left Blank</i>
2003	<i>Intentionally Left Blank</i>
2004	Results charted from DocketNavigator.com Document Search, run on October 8, 2024, for Motion to Stay Pending <i>Inter Partes</i> Review Decided by Judge Rodney Gilstrap
2005	Results charted from DocketNavigator.com Document Search, run on October 8, 2024, for Motion to Stay Pending <i>Inter Partes</i> Review Decided by Judge Rodney Gilstrap with "Stipulated/Agreed" Motions Removed
2006	Federal Court Management Statistics (June 30, 2024)
2007	Order Denying Maxeon Partial Motion to Dismiss (Dkt. 26), <i>Maxeon Solar Pte. Ltd. v. Canadian Solar, Inc.</i> , Case No. 2:24-cv-00210-JRG (E.D. Tex.), July 3, 2024
2008	Docket Control Order (Dkt. No. 33), <i>Maxeon Solar Pte. Ltd. v. Canadian Solar, Inc.</i> , Case No. 2:24-cv-00210-JRG (E.D. Tex.), August 7, 2024
2009	Canadian Solar Inc.'s Invalidity Contentions, <i>Maxeon Solar Pte. Ltd. v. Canadian Solar, Inc.</i> , Case No. 2:24-cv-00210-JRG (E.D. Tex.), September 6, 2024
2010	<i>Intentionally Left Blank</i>
2011	<i>Intentionally Left Blank</i>
2012	<i>Intentionally Left Blank</i>
2013	<i>Intentionally Left Blank</i>
2014	<i>Intentionally Left Blank</i>
2015	Granek et al., "Front surface passivation of n-type high-efficiency back junction silicon solar cells using front surface," <i>Solar Energy Materials and Solar Cells</i> , 91(7) (2007)

Exhibit	Description
2016	“Nanotechnology improves solar cell efficiency,” <i>EarthSky</i> , August 28, 2007 (accessible at https://earthsky.org/humanworld/nanotechnology-improves-solar-cell-efficiency ; last accessed October 14, 2024)
2017	“New Plastic Solar Cell Breaks Efficiency Record,” <i>ScienceDaily</i> , April 20, 2007 (accessible at https://www.sciencedaily.com/releases/2007/04/070419140902.htm), last accessed October 14, 2024)
2018	Capshaw-Mack, C., “Power Games: Project seeks to improve methods of harnessing solar energy,” <i>Winston-Salem Journal</i> , August 4, 2013 (accessible at https://journalnow.com/news/local/article_1d243ff0-fc9e-11e2-b607-001a4bcf6878.html ; last accessed October 15, 2024)
2019	<i>Intentionally Left Blank</i>
2020	Declaration of David L. Carroll, Ph.D. in Support of Patent Owner Preliminary Response for IPR2024-01194
2021	Declaration of David Carroll, Ph.D. in Support of Patent Owner Response for IPR2024-01038
2022	Transcript of deposition of Sanjay Banerjee, Ph.D. taken March 21, 2025
2023	Transcript of deposition of Sanjay Banerjee, Ph.D. taken March 20, 2025
2024	Lamers et al., “Towards 21% Efficient N-CZ IBC Based on Screen Printing,” <i>26th European Photovoltaic Solar Energy Conference and Exhibition</i> , (2011) (“Lamers”)
2025	Desa et al., “Optimization of p-type Screen Printed Interdigitated Back Contact Silicon Solar Cell with Aluminum Back Surface Field,” <i>International Journal of Engineering & Technology IJET-IJENS</i> , 14(2) (2014) (“Desa”)
2026	Procel et al., “Analysis of the Impact of Doping Levels on Performance of Back Contact – Back Junction Solar Cells,” <i>4th International Conference on Silicon Photovoltaics, SiliconPV 2014</i> , Italy, 2014, pp 128-132, ScienceDirect (“Procel”)

Exhibit	Description
2027	U.S. Patent No. 8,790,957 to Li et al.
2028	Schulz, M., "Interface States at the SiO ₂ -Si Interface," <i>Surface Science</i> 132 (1983)
2029	Aoki, M., et al., "Intrinsic Gettering of Iron Impurities in Silicon Wafer," <i>Japanese Journal of Applied Physics</i> , Vol. 30, No. 12B, pp. 3580-3583 (Dec. 1991)
2030	Ziebarth, B., et al., "Interstitial Iron Impurities at Grain Boundaries in Silicon: A First-Principles Study," <i>Physical Review B</i> 91 (2015)
2031	Portavoce A., et al., "Redistribution of Metallic Impurities in Si During Annealing and Oxidation: W and Fe," <i>Defect and Diffusion Forum</i> , Vol. 383, pp. 17-22 (2018)
2032	Hajjiah, A., et al., "The Impact of Interstitial Fe Contamination on N-Type Cz-Silicon for High Efficiency Solar Cells," <i>Solar Energy Materials & Solar Cells</i> 211 (2020)
2033	Coletti, G., "Sensitivity of State-of-the-Art and High Efficiency Crystalline Silicon Solar Cells to Metal Impurities," <i>Prog. Photovolt: Res. Appl.</i> 2013; 21:1163-1170 (2012)
2034	Castellanos S., et al., "Exceeding 3 ms Minority Carrier Lifetime in n-Type Non-Contact Crucible Silicon," <i>Energy Procedia</i> 92, pp. 779-784 (2016)
2035	Sopori, B., "Impurities and Defects in Photovoltaic Si Devices: A Review," <i>10th Int'l Workshop on the Physics of Semiconductor Devices</i> , Delhi, India, Dec. 13, 1999
2036	EAG Laboratories, "SIMS Detection Limits of Selected Elements in Si and SiO ₂ Under Normal Depth Profiling Conditions"
2037	Haarahiltunen, A., et al. "Detection of Iron Contamination in Internally Gettered P-Type Silicon Wafer by Lifetime Measurements"
2038	Liu, A., et al, "Understanding the Impurity Gettering Effect of Polysilicon/Oxide Passivating Contact Structures Through Experiment and Simulation," <i>Solar Energy Materials and Solar Cells</i> 230 (2021)

Exhibit	Description
2039	Declaration of Dr. Mary K. Bolin

I. INTRODUCTION

Three themes run through Petitioner's Reply. *First*, Petitioner refuses to acknowledge the proper legal standard for its theories. For example, Petitioner devotes much of its Reply to the proposition that some amount of iron *may* migrate from Li's substrate to Li's material layer. However, under the proper legal standard, Petitioner must show that Li's material layer *necessarily* includes iron and specifically in a detectable amount. Petitioner does not do that. *Second*, Petitioner seeks to supplement the arguments in the Petition with new legal theories. For example, Petitioner urges that dopants in Li's material qualify as "metal impurities." This theory is absent from the Petition. Also, Petitioner has abandoned the argument that King, Swanson-352, and Marvin establish an "optimal" dopant concentration and instead argues that it would have been "obvious to try" the dopant concentration found in those references. That is another theory that is absent from the Petition. *Third*, Petitioner ignores facts that undermine its theories. For example, Patent Owner noted that the durations of heat treatments in the prior art are much longer than the heat treatment of Li. Petitioner's Reply does not address that key issue.

Petitioner has not remedied the failures of the Petition in showing either the "metal impurities" or "dopant concentration" limitations. The Board should affirm the patentability of the challenged claims.

II. ARGUMENT

A. Li Does Not Inherently Disclose the “metal impurities” Limitation

1. *Petitioner Fails to Show that Li's Material Layer Necessarily Includes a Recognizable and Non-De Minimis Level of Iron Impurities*

The parties' factual dispute as to whether iron from Li's substrate necessarily travels to Li's material layer is easily resolved under the proper legal framework. Petitioner fails to carry its burden at multiple junctures.

a. Petitioner Continues to Assume an Improperly High Level of Iron in Li's Substrate

Petitioner fails to state what it believes is the level of iron that must be in Li's substrate. Largely, this is because Petitioner fails to recognize the proper legal framework. In particular, Petitioner preoccupies itself with the level of impurities of allegedly “standard” or “commonly-used” silicon substrates. Reply at 1-5. Petitioner operates under the wrong legal standard. Inherency, upon which Petitioner relies, requires that the “missing descriptive matter in a prior art reference is nevertheless *necessarily present*.” *HTC Corp. v. Cellular Commc'ns Equip., LLC*, 877 F.3d 1361, 1368 (Fed. Cir. 2017) (emphasis added). “The mere fact that a certain thing *may* result from a given set of circumstances is not sufficient.” *PersonalWeb Techs., LLC v. Apple, Inc.*, 917 F.3d 1376, 1382 (Fed. Cir. 2019) (emphasis in original). Petitioner appears to be *sub silentio* advocating for a lower bar. Its factual contentions about what *could* be the iron concentrations

in Li's substrate are not explainable otherwise. However, unless and until the law on inherency is changed, the bar remains high—necessity is the standard.

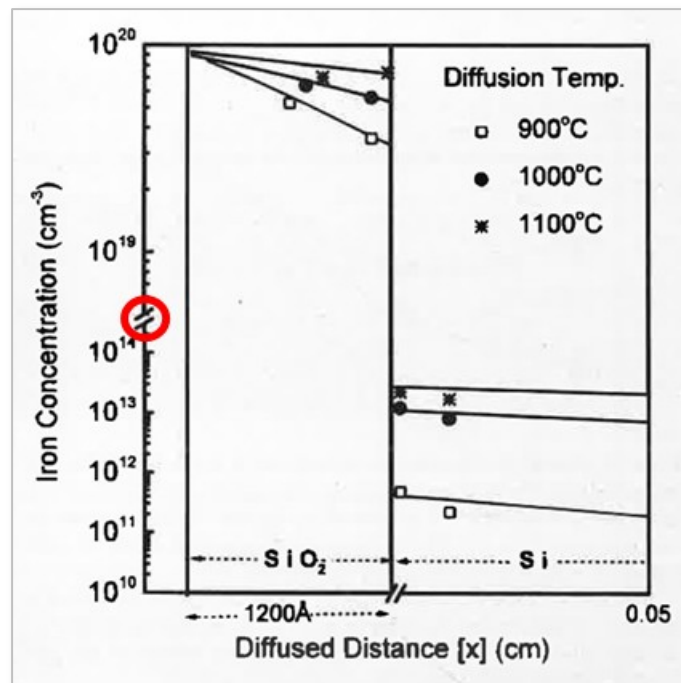
Thus, a proper inherency argument—based on necessity rather than possibilities or probabilities—would consider the lowest levels that Li's substrate could contain. In this regard, Petitioner does not effectively rebut Patent Owner's evidence that established the iron concentration in Li's substrate could have been as low as 10^{11} cm^{-3} .²

Petitioner misses the mark when it conflates the “extraordinarily” high lifetime that certain SunPower substrates exhibited with the phrase “extraordinary measures” found in certain cases. Reply at 5. The former is achievable without the latter. Indeed, Neuhaus defeats Petitioner's argument when it states that “extraordinarily high lifetime silicon starting material” is ***required*** in interdigitated back contact (IBC) solar cells. Ex. 1011 at 11. IBC solar cells have been known since 1977 and were “commercialized” by SunPower. *Id.*, 11, 13. The measures that are ***required*** to make a ***commercial*** product cannot reasonably be considered “extraordinary.”

² The unit “ cm^{-3} ” refers to the number of atoms per cubic centimeter.

b. Petitioner Continues to Fail to Account for “Pileup” at the Layer Interfaces

Even crediting Petitioner's conjecture about what the iron concentration in Li's substrate *could* be, Petitioner fails to carry its burden in view of the interfaces on either side of Li's oxide layer. Those interfaces would prevent a recognizable and non-*de minimis* amount of iron in Li's material layer. Curiously, Petitioner cites Figure 5 of Ramappa to support the assertion that iron “*readily passes through the interface* between the silicon oxide and silicon substrate.” Reply at 14 (emphasis added). That is an odd takeaway from the figure, which shows an extreme disparity between the iron concentrations on either side of the interface.



Ex. 1025, Fig. 5 (annotated).

The disparity is so great that Ramappa had to break the y-axis (as indicated by the red circle above) to remove multiple orders of magnitude so that the concentrations on either side of the interface could be displayed on the same graph. Specifically, the iron concentrations across the Si-SiO₂ interface at 900°C differ by a factor of 60 million. POR at 19-20; Ex. 2021, ¶59. Petitioner does not dispute that. Dr. Carroll opines that the disparity across the SiO₂-polysilicon interface in Li (the second interface that iron would have to traverse) would be similar. Ex. 2021, ¶60. Petitioner does not dispute that either. Thus, as Dr. Carroll calculated, a starting concentration of 10^{14} cm^{-3} —which is the midpoint of “the range of 10^{13} - 10^{15} cm^{-3} ” mentioned on page 3 of Petitioner’s Reply—would yield far less than a single atom of iron per cubic centimeter of Li’s material layer. Ex. 2021, ¶60.³

Petitioner does not show error in Dr. Carroll’s calculations. Petitioner disparages the calculations as being “unfounded,” Reply at 13, but fails to state why that is so. Nor can Petitioner seriously dispute Dr. Carroll’s calculations. They are basic arithmetic: dividing the iron concentration initially in the substrate by the “pileup” effect at the substrate-oxide interface and then again at the oxide-polysilicon interface. Ex. 2021, ¶60. Similarly, Petitioner complains that Dr.

³ Even this calculation is likely too high as it is based on Ramappa’s 90-minute heat treatment, whereas Li’s heating process is likely much shorter. POR at 24-25.

Carroll's calculations "fail to account for increased gettering that results from simultaneous doping." Reply at 18. However, Petitioner fails to explain how dopants in Li's material layer would lessen the "pileup" characteristics of the interfaces, which are located upstream (i.e., closer to the iron's starting point) from the material layer. Of course, iron must cross those interfaces before it can become trapped in the material layer. Regardless, Petitioner fails to proffer any alternative calculations.

The Liu-1 and Liu-2 references do not save Petitioner's inherency argument. Both references post-date the priority date of the '315 patent and thus are relevant only as far as they describe facts regarding other prior art. *See In re Wilson*, 311 F.2d 266, 368-69 (C.C.P.A. 1962). They do not. *First*, the heat treatment in Liu-1 and Liu-2 was more than **15 times longer** than the expected (but unspecified) duration of the heat treatment in Li. POR at 25. Petitioner does not dispute either the calculations behind that or Dr. Carroll's opinion that the duration of the heat treatment step is "crucial" in determining whether iron impurities migrate to Li's material layer. Ex. 2021, ¶¶84-89. *Second*, the polysilicon layer in Liu-1 begins "heavily doped" while the material layer in Li begins undoped. Of course, the doping of Li's material layer would not retroactively increase gettering during the time that it was undoped. *Third*, there is no evidence that other relevant factors

such as the surface preparation and layer formation in Li must necessarily be the same as in Liu-1/Liu-2.

Petitioner's reliance on Liu-1 and Liu-2 is faulty for additional reasons. Regarding Liu-1, Petitioner interprets Figure 7 of that reference differently than its authors. While Petitioner cites the figure as alleged support for its inherent gettering argument, Reply at 15-16, Liu-1 itself believes the figure shows "a poor gettering effect." Ex. 1028, p. 2279. Regarding Liu-2, the reference measured iron impurities remaining near the surface of a silicon wafer but not in a polysilicon layer. Ex. 2021, ¶¶64-65. Stated differently, Liu-2 does not disclose what percentage of iron becomes trapped in the "impurity sinks" formed on either side of the oxide layer and what percentage ultimately travels to the polysilicon layer.

c. Petitioner Fails to Show that the Iron Concentrations of Li's Material Layer Would Have Been Detectable

The record establishes that Dr. Carroll's calculated iron concentrations—the only calculations put forward by either party—would have been beyond the reach of any detection means. The parties dispute what the limits of detection were in 2014, but regardless of which party is correct, they fall short by many orders of magnitude. Patent Owner submits that the limit was close to that disclosed in Liu-

1, i.e., $5 \times 10^{15} \text{ cm}^{-3}$. Ex. 1028, p. 2278; *see also* Ex. 2021, ¶60.⁴ Petitioner cites a passage from Ramappa suggesting that by “[u]sing the technique of surface photovoltage,” the background level of iron contamination in starting wafers could be “established” to be $7 \times 10^{10} \text{ cm}^{-3}$. Reply at 13. Petitioner does not explain what the “technique of surface photovoltage” is or whether it could be employed to measure iron in Li’s material layer. However, that sensitivity, which is nearly ten thousand times greater than that disclosed in Liu-1 (which was published nineteen years later), is interesting indeed. Regardless, even such an acute detection method would fall well short of measuring concentrations calculated by Dr. Carroll. Indeed, Petitioner would need a method at least two trillion times more sensitive to measure iron in concentrations of $2.7 \times 10^{-2} \text{ cm}^{-3}$, which is on the conservative end of Dr. Carroll’s calculations. Ex. 2021, ¶60. Another three orders of magnitude would be required to measure concentrations of 2.7×10^{-5} , which Dr. Carroll notes is possible in Li’s material layer. *Id.*

Petitioner misreads Dr. Carroll’s deposition testimony when it alleges that he admitted that his calculated levels could be detected. Reply at 13. Dr. Carroll testified to the contrary. Specifically, he noted the most acute forms of detection

⁴ There are 5×10^{22} atoms of silicon per cubic centimeter. Ex. 2022, 85:4-6. Thus, a sensitivity of $5 \times 10^{15} \text{ cm}^{-3}$ can detect iron concentrations of 0.00001%.

were ***destructive*** techniques that essentially “evaporate” a solar cell and then “look at the gas.” Ex. 1087, 86:13-15. Even then, those techniques could yield “one or two sigma” confidence—far short of the “standard for the field [of] six sigma.” *Id.*, 87:10-15. This led Dr. Carroll to note “how ***far away*** you would still be even using the best detectability at your disposal in 2014.” *Id.*, 87:16-17 (emphasis added). Thus, Dr. Carroll made clear that—rather than being able to detect the concentrations he calculated—one would be “far away” from doing so even using the most advanced (and destructive) techniques available.

Similarly, Petitioner does not explain away the Liu-1 reference, upon which it relies when convenient, which discloses a lower detection limit for iron of 5×10^{15} cm⁻³. Ex. 1028, p. 2278 (Fig. 4). If the concentrations that Dr. Carroll calculated were in fact detectable, then Liu-1 is shockingly wrong.

For the same reasons that Li's material layer need not (and likely does not) include a detectable level of iron, it need not (and likely does not) include a “trace” amount of that metal. This is because a “trace” amount is per se detectable. POR at 35. Petitioner alleges that definition is unsupported, Reply at 12, but fails to proffer an alternative definition. Petitioner misreads *Ex Parte Nye* when it suggests that the case equated a “trace” amount with a single molecule. Reply at 13. In that case, the Board held that an obviousness finding requires a “determination that more than a ***de minimis*** and ***unrecognizable*** quantity of [the

claimed substance] is necessarily present in [the prior art].” *Ex Parte Nye*, Appeal No. 2010-001708, 2011 WL 3798745, at *5 (B.P.A.I. Aug. 25, 2011) (emphasis added). This defeats Petitioner’s assertion that a single molecule would have been sufficient. Reply at 12-13.⁵

Indeed, Petitioner’s apparent position that a single molecule of a substance could satisfy inherency is contrary to *In re Seaborg*, 328 F.2d 996 (C.C.P.A. 1964) and *Crown Packaging Tech., Inc. v. Ball Metal Beverage Container Corp.*, 635 F.3d 1373 (Fed. Cir. 2011). Petitioner fails to harmonize its position with those controlling authorities.

For these reasons, Petitioner’s assertion that it is “undisputed” that “trace” amounts of metal impurities would be present in Li’s material layer, Reply at 13, is false.

d. Inherency Cannot Be Established in the Absence of Detectability

Petitioner alleges to have found a path to inherency that does not exist when it argues that it does not need to show that the prior art results in at least a trace

⁵ To be sure, the failure to show that a molecule was produced was fatal to the Examiner’s obviousness rejection. However, the *Nye* panel never suggested the rejection would have been upheld based on the presence of a single molecule. Stated differently, a molecule is necessary but not sufficient.

(detectable) amount of a claim requirement. Specifically, Petitioner argues that inherency may be demonstrated by showing that *either* (1) an outcome is the “natural result” of a process disclosed in the prior art or (2) the prior art results in at least a trace amount of a claim requirement. Reply at 5-6; *see also id.* at 12. Petitioner is mistaken. The Federal Circuit has held that “inherent anticipation requires . . . more than the presence of an *unrecognized de minimis* quantity.” *Crown Packaging*, 635 F.3d at 1383 (emphasis added). That settles the matter. The sole authority cited by Petitioner is not in tension with *Crown Packaging* and does not support Petitioner. Petitioner cites *Allergan, Inc. v. Apotex Inc.*, 754 F.3d 952 (Fed. Cir. 2014), but in that case the Federal Circuit reiterated that “inherent anticipation can be found based on a trace amount.” *Id.* at 961. This holding means that abundant amounts of a substance are not required. It does not mean that something short of a trace is sufficient.

The requirement of detectability applies for all patents, not just those that claim “a previously-undisclosed element or compound,” as Petitioner suggests. Reply at 12. None of the cases cited by Petitioner hint that they are applying anything other than a universally-applicable rule. Further, neither of the PTAB decisions cited by Patent Owner, POR at 34-35, recognize the distinction Petitioner urges. Indeed, those cases dealt with well-known (as opposed to “previously-undisclosed”) concepts such as an assembly being “compressively held” in a housing

and administering a gas with “ambient air.” *Ex Parte Landis*, Appeal No. 2011-011290, 2014 WL 2989993 (PTAB July 1, 2014); *Ex Parte Petzelt*, Appeal No. 2010-008850, 2011 WL 5288877 (B.P.A.I. Nov. 2, 2011). Petitioner did not address either case in its Reply.

Petitioner conflates disparate issues when it alleges that “there is no requirement that metal impurities in the polysilicon layer must have been ‘recognized.’” Reply at 6. Petitioner confuses cases that have discussed *appreciation* of an inherent element (which is not required) with the concept of *detectability* (which is required). For example, Petitioner cites *MEHL/Biophile Int’l Corp. v. Milgraum*, 192 F.3d 1362 (Fed. Cir. 1999) which held, “Where, as here, the result is a necessary consequence of what was deliberately intended, it is of no import that the article’s authors did not *appreciate* the results.” *Id.* at 1366 (emphasis added). The other cases cited by Petitioner hold similarly. Although some use “recognize” instead of “appreciate”, the holdings are the same—the prior art need not appreciate that its disclosure necessarily would lead to an element, but the element must be created in an amount that could be detected.

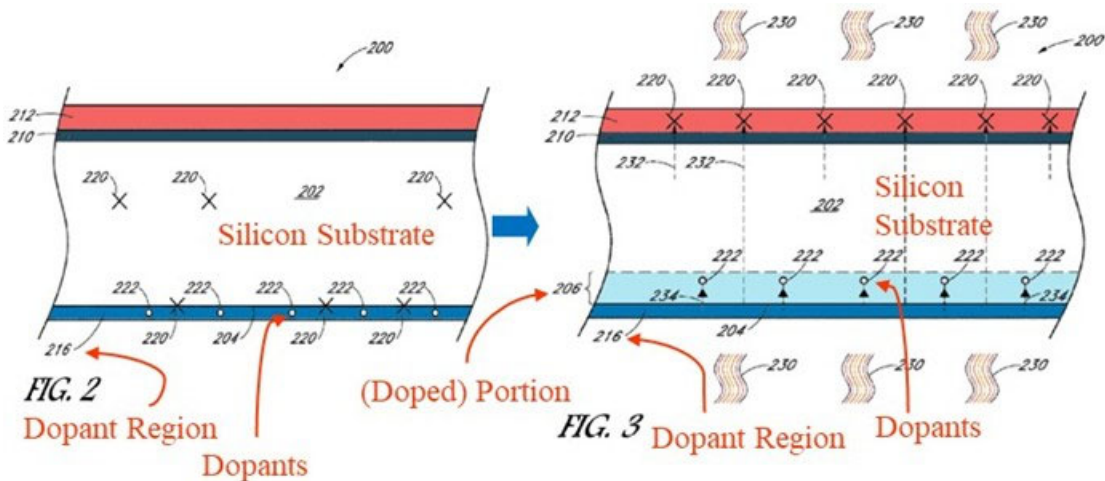
2. *The ’315 Patent Does Not Create Disclosure in Li*

Petitioner cannot shirk its burden to show inherency by drawing alleged parallels between Li and the ’315 patent. See Reply at 7-11. Li and the ’315 patent

are markedly different: each employs a doping process and heating steps unlike those in the other.

a. The '315 Patent and Li Employ Different Doping Processes

The '315 patent introduces dopants into a silicon substrate by first forming a dopant region on a surface of the substrate and then heating. An exemplary embodiment is shown in Figures 2 and 3:



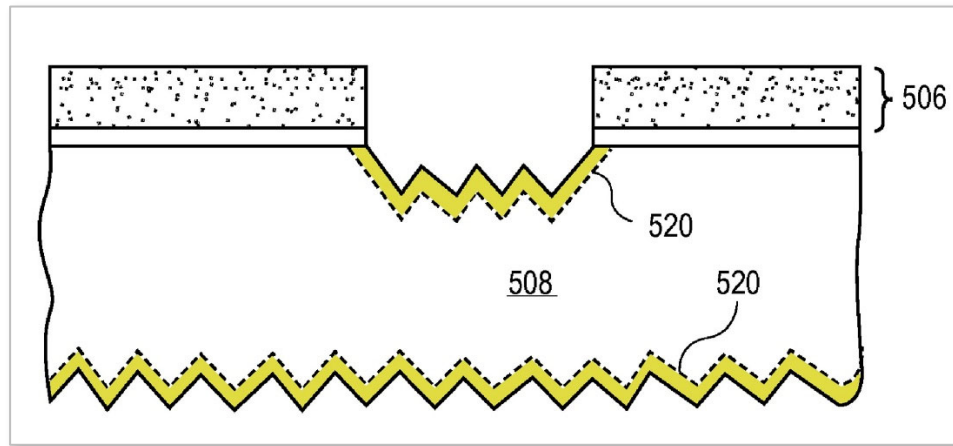
Ex. 2021, ¶101.

In that exemplary process, “a dopant region 216 [dark blue] can be formed on a surface 204 of silicon substrate 202 [white],” and a high-temperature heating step drives “the dopants 222 from the dopant region 216 to a portion 206 [light blue] of the silicon substrate 202.” Ex. 1001, 4:55-56, 5:64-67.

By contrast, Li discloses a gaseous dopant source. Li discloses, “In one embodiment, heating substrate 508 includes heating in the presence of a gaseous

N-type dopant source and doping, with the gaseous N-type dopant source, substrate 508 at or near surfaces of substrate 508 not covered by material layer 506.” Ex.

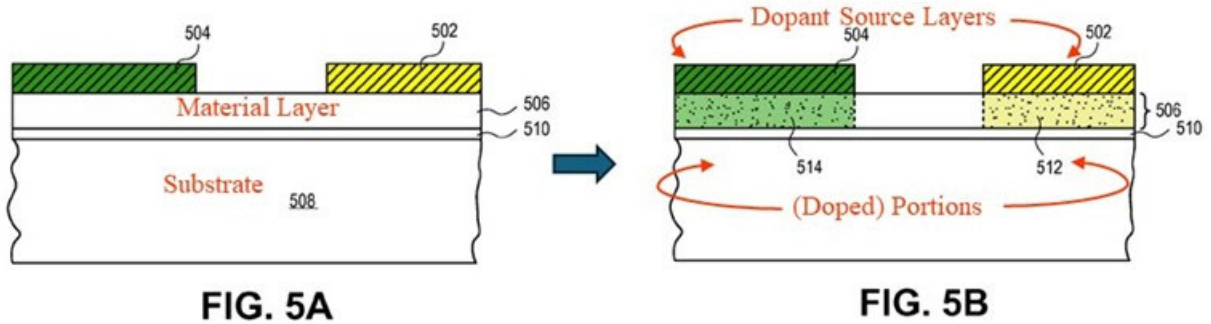
1005, ¶[0049]. The resultant dopant regions 520 are highlighted in the image below:



Ex. 1005, Fig. 5E (annotated).

b. The '315 Patent and Li Employ Different Heating Steps

Petitioner's attempt to draw parallels between the heating steps falters when Petitioner conflates different dopant diffusion steps. Petitioner alleges that “[i]n Li, dopant diffusion is conducted above 900°C, *just like in the 315 Patent.*” Petition at 44 (emphasis added). Petitioner confuses two distinct heating steps in Li. Petitioner cites paragraph [0045] of Li, which discusses the diffusion of dopants to form emitter regions, which is on the back side of Li. Specifically, that paragraph discusses the transfer of dopants from dopant source layers 502 and 504 into portions 512 and 514 of material layer 506, as depicted in Figures 5A and 5B of Li:



Ex. 2021, ¶103.

That high-temperature process is distinct from the gaseous diffusion step that forms dopant regions 520. Indeed, the dopant regions 520 are formed several steps later by “heating substrate 508 . . . in the presence of a gaseous N-type dopant source.” Ex. 1005, ¶[0049]; *see also* Ex. 2021, ¶¶104-106.

c. The Foregoing Differences Impact Whether Metal Impurities Would Be Present in the Emitter Region

The foregoing differences are critical with respect to the presence of metal impurities in the emitter region. Dr. Carroll testified that the foregoing differences “would affect whether metal impurities are present in the emitter region.” Ex. 2021, ¶100. As he explained, the “timing differences are significant because a person of ordinary skill in the art would have understood the need to account for the thermal history of the substance when implementing additional heating steps.” Ex. 2021, ¶104.

Petitioner fails to counter Dr. Carroll’s testimony with competent evidence. Instead, Petitioner devotes a single footnote of attorney argument to the issue.

Reply at 8 n.4. Those arguments are unavailing. Petitioner argues that because the '315 patent contemplates processes other than those specifically described, all other processes will achieve the results claimed in the '315 patent. *Id.* The '315 patent provides that “each layer or substance can be formed using any appropriate process” and allows for “at least one other heating step . . . before the heating process of block 106 [when the gettering and dopant diffusion occurs].” Ex. 1001 at 4:32-37, 5:47-49. However, Petitioner's conclusion does not follow. The '315 patent does not disclose, much less suggest, that *any* dopant formation process is an “appropriate” process or that *any* number of heating steps is acceptable. Rather, the '315 patent simply noted that a skilled artisan may be able to practice the invention by modes other than those specifically disclosed.

Petitioner cites inapposite cases. In *MEHL/Biophile*, the plaintiffs did not dispute that the operating parameters disclosed in the prior art “substantially coincide with those disclosed in the patent.” *MEHL/Biophile*, 192 F.3d at 1366. There is no substantial coincidence here, as discussed above. For similar reasons, *In re Wiegand*, 182 F.2d 633 (C.C.P.A. 1950) is inapposite. In that case, the applicants had “not challenged the findings of similarity between [their] process on the one hand and the [prior art processes] on the other hand” except those that were “no more than a difference of degree.” *Id.* at 1106, 1108. Petitioner also cites *King Pharms., Inc. v. Eon Labs, Inc.*, 616 F.3d 1267 (Fed. Cir. 2010). However, in that

case, the patent declared that the “natural result of taking metaxalone with food is an increase in the bioavailability of the drug [metaxalone].” *Id.* at 1275. Thus, the court held that “to the extent such a method [disclosed in the specification] increases the bioavailability of metaxalone, the **identical** prior art method does as well.” *Id.* at 1276 (emphasis added). By contrast, the '315 patent does not state that the natural result of heating over 900°C is gettering, and Li and the '315 patent are not “identical.” Rather, the '315 patent observed gettering for certain specific circumstances. Ex. 1001, Fig. 11. The '315 patent does not state that gettering occurs at 900°C regardless of, for example, (i) the duration of the heating, (ii) the purity of the silicon substrate, and (iii) the condition of the interfaces at either side of the oxide layer. Such a categorical statement would have been technically indefensible, just as it is now coming from Petitioner. Ex. 2021, ¶¶68, 74.

3. *Petitioner's Admission that Boron Is Used in Its Proposed Combinations Further Undermines Its Inherency Arguments*

Rather than escape the problem Patent Owner highlighted in its Response with respect to the use of boron as a dopant (POR at 32-33), Petitioner has multiplied it. Petitioner states that “[t]he process of doping Li's backside polysilicon regions **with boron** and phosphorous via dopant source regions is the same in the Li-Muller combination **as in all other combinations.**” Reply at 20 (emphasis added). Until its Reply, Petitioner had not specified the element(s) used as dopants for Li's backside polysilicon regions, although the combinations with

Muller strongly suggested boron (as that element was used on the front side).

Petitioner now states that boron is used on the back side in all combinations. That is a problem for Petitioner. Liu-1 teaches that boron obstructs gettering. POR at 33; *see also* Ex. 1028, p. 2279 (“[T]he B-doped [boron-doped] poly-Si layer on its own exhibits a poor gettering effect.”). It is now clear that Petitioner proposes to use boron for the P-type region 310 of Li. Petitioner has been unclear as to whether it believes that region corresponds to the first or second emitter region of the claims. Petition at 42-43. Regardless, the boron will either (i) block the alleged first emitter region from absorbing metal impurities (as required by claim 10) or (ii) block the alleged second emitter region from absorbing metal impurities (as required by claim 16). Petitioner’s clarification that it proposes boron as the dopant for the P-type region 310 of Li in “all” combinations reveals that *all* its grounds suffer under this Catch-22.

B. Petitioner’s New “Expressly Adding” Argument Should be Rejected

The Board should reject Petitioner’s back-up obviousness argument as being untimely. An IPR petition must identify “with particularity . . . the grounds on which the challenge to each claim is based.” 35 U.S.C. § 312(a)(3). This rule prohibits petitioners from advancing in a reply “an entirely new theory of *prima facie* obviousness absent from the petition.” *Wasica Finance GmbH v. Continental Auto. Sys., Inc.*, 853 F.3d 1272, 1286 (Fed. Cir. 2017). In this case, Petitioner did

not articulate an obviousness theory in the Petition. Instead, as Patent Owner explained in its Response, Grounds 3 and 4 merely repackage the inherency arguments of Grounds 1 and 2. POR at 36-38.

Additionally, Petitioner's new, cursory obviousness argument fails on the merits. Petitioner does not describe with particularity the changes to Li a person of ordinary skill in the art allegedly would have been motivated to make. The closest Petitioner comes is the suggestion that "e.g., modifying heating processes" could have been performed. Reply at 21. However, Petitioner does not explain what those changes would have entailed much less that such changes would have been "on balance, desirable," as controlling law requires. *See Winner Int'l Royalty Corp. v. Wang*, 202 F.3d 1340, 1349 (Fed. Cir. 2000). This is especially true since other methods of removing impurities were known. *See* Ex. 1011 at 2. Further, Petitioner's theory does not enjoy expert witness support. Dr. Banerjee did not opine that modifying Li to "expressly" getter (by some unknown mechanism) would have been obvious and indeed conceded that each of his unpatentability opinions depends on inherency. Ex. 2022, 67:15-22.

C. Petitioner's New Dopant-as-Impurity Argument Should be Rejected

Petitioner advances another new theory when it urges—in a single footnote—that dopants in Li's polysilicon layer satisfy the "metal impurities" limitation. Reply at 7 n.3. That theory is untimely as it is absent from the Petition.

See Wasica, 853 F.3d at 1286. It also mischaracterizes Dr. Carroll's testimony. In fact, he testified that whether a dopant can be considered an impurity depends on "context" and that solar cell literature "almost never include[s] the idea that a dopant is an impurity." Ex. 1087, 35:21-36:3.

D. It Would Not Have Been Obvious to Use Dopant Concentrations of King, Swanson-352, or Marvin in Li

1. Petitioner Cannot Change Obviousness Theories

Petitioner has retreated from the untenable position that $2 \times 10^{18} \text{ cm}^{-3}$ was the "optimal" dopant concentration in all circumstances. Now, Petitioner argues that concentration was merely one of a "finite number" of doping concentrations and that it would have been "obvious to try" it. Reply at 23. The Board should not entertain this new theory. It is improper for a petitioner to introduce a "new, additional obviousness rationale" in its reply. *Samsung Elecs. Co., Ltd. v. Resonant Sys., Inc.*, IPR2023-00993, Paper 48, 2025 WL 49851, at *17 (PTAB Jan. 8, 2025). That is what Petitioner has done here. Petitioner introduces the heretofore unmentioned "finite number" / "obvious to try" rationale. Neither those phrases nor anything similar appear in the Petition.

Petitioner's new theory also should be rejected on its merits. "[I]t is 'improper' to argue an obviousness theory on the basis that 'it would have been 'obvious to try' . . . to vary all parameters or try each of numerous possible choices until one possibly arrived at a successful result." *Dell Inc. v. Realtime Data LLC*,

IPR2016-00972, Paper 71, 2018 WL 2247172, at *8 (PTAB May 15, 2018)

(quoting *In re Kubin*, 561 F.3d 1351, 1359-60 (Fed. Cir. 2009)). Petitioner's theory is based on that faulty notion. Petitioner suggests that a person of ordinary skill in the art could have determined an appropriate dopant concentration for Li because none of the numerous relevant considerations are "restricted by Li's disclosure." Reply at 23. The lack of disclosure in Li does not help Petitioner. Rather, Li's silence leaves a skilled artisan without guidance toward the claimed dopant concentration. Indeed, Petitioner fails to posit a set of parameters that it believes would lead a skilled artisan to select a dopant concentration in Li of less than $2 \times 10^{18} \text{ cm}^{-3}$. Petitioner's optimism that such a set of parameters may exist is not an adequate substitute. See *KSR Int'l Co. v. Teleflex Inc.*, 550 U.S. 398, 418 (2007) ("[I]t can be important to identify a reason that would have prompted a person of ordinary skill in the relevant field to combine the elements in the way the claimed new invention does.").

2. *Petitioner Cannot Rely on New and Undefined Combinations*

For the first time in this proceeding, Petitioner hints that its proposed combination for Grounds 1 and 3 may not be a single combination but perhaps multiple, undefined combinations. Specifically, Petitioner contends that it is "erroneous" to understand Grounds 1 and 3 to be based on maintaining Li in a 1-sun (non-concentrator) and terrestrial environment. Reply at 22. That is

surprising. The Petition does not suggest employing Li in a concentrator environment or in a space environment. Indeed, Dr. Banerjee's "baseline assumption" was that the combination was "meant for terrestrial applications." Ex. 2022, 103:3-17. Further, even in its Reply, Petitioner strongly suggests a terrestrial application when it cites impurity concentrations in silicon substrates destined to remain on the ground. For example, on pages 2-3 of its Reply, Petitioner cites deposition testimony from Dr. Carroll in which he was asked about impurity levels in substrates "for terrestrial purposes." Ex. 1087, 28:18-29:2. Dr. Carroll noted such substrates are typically "lower-quality" and distinguished those substrates from those for space applications which "use really good silicon to begin with." Ex. 1087, 28:4-7; *accord id.*, 25:5-9.

Indeed, even though Petitioner hints that it may have had a concentrator and/or space-based application in mind, it stops short of committing itself to any particular application.⁶ Perhaps, Petitioner desires a terrestrial application for purposes of the "metal impurities" limitation but desires a space application for purposes of the "dopant concentration" limitation. If so, this is reason enough to dismiss Grounds 1 and 3. Petitioner cannot carry its burden if it is unable to

⁶ Petitioner alludes to "identified circumstances," but unhelpfully fails to identify what those circumstances are. Reply at 24.

describe an alleged combination that satisfies all claim elements. *See Kimberly-Clark Corp. v. Johnson & Johnson*, 745 F.2d 1437, 1448 (Fed. Cir. 1984) (“The proper approach to the obviousness issue must start with the claimed invention *as a whole*.”) (emphasis in original).

3. *Petitioner Does Not Propose Modifying Li to Include an Oxide Passivation Layer*

Petitioner does not dispute that Li's substrate does not include an oxide passivation layer on its front side. Instead, Petitioner insists that Li does not “preclude” such a layer. Reply at 25. That contention may have been relevant if Petitioner had alleged it would have been obvious to modify Li to add such a layer. Petitioner did not do so.

Petitioner is not aided by the fact that benefits attend passivated surfaces. Reply at 25. Passivation can take many forms, of which an oxide layer is only one. For example, Dr. Carroll testified that at the time of the invention, “people were beginning to use the urea-based polymers . . . in terms of adding a passivation layer, it didn't necessarily need to be silicon dioxide” and that “[i]t could've been a spray-on polymer.” Ex. 1087, 193:15-19. That testimony is un rebutted. Accordingly, even if a skilled artisan would have been motivated to passivate Li's front surface, they would not have had to do so with oxide layers similar to those in King, Swanson-352, or Marvin. Petitioner resorts to a strawman argument when it states that “Maxeon's ‘critical’ assumption that Li *cannot* employ a passivating

oxide layer on the front surface . . . is baseless.” Reply at 25 (emphasis added).

Patent Owner did not make that argument; just as Petitioner did not argue that adding an oxide layer would have been obvious.

E. The Proposed Li-Muller Combination Would Not Have Been Obvious

Petitioner's Reply does not remedy the shortcomings of the Li-Muller combination proposed in the Petition.⁷

Petitioner does not effectively rebut the evidence that shows Muller's process is contrary to Li's stated objective of reducing processing operations. Instead, Petitioner misreads Li when it alleges that the reference “expressly contemplates ‘additional heating or anneal operation[s].’” Reply at 29-30. The full and unaltered quotation of Li reveals something different:

[U]sing process flows such as those described in detail herein may be preferable over conventional flows even through *some of the process flows described herein* include an additional heating or anneal operation.

⁷ Petitioner does not dispute that Dr. Banerjee “hadn't really looked at Muller,” as he testified. Ex. 2022, 170:8. That admission undercuts Dr. Banerjee's opinions cited in support of Grounds 2 and 4.

Ex. 1005, ¶[0024] (emphasis added).⁸ Li's recognition that its process flows may include an additional operation relative to conventional flows is not the same as contemplating still further additional processes. Regardless, even if Li contemplated additional processes, Petitioner would still have to show that Muller's process would yield benefits *relative to Li*. Petitioner failed to address that issue. Similarly, Petitioner failed to rebut Dr. Carroll's testimony that Muller's ion implantation process is more expensive. Ex. 1087, 207:18-208:4.

Petitioner also errs in relying on benefits in the proposed combination that are illusory. Petitioner compares its proposed Li-Muller combination to alternative embodiments of the secondary reference (Muller) and not the primary reference it proposes to modify (Li). The only purported benefit Petitioner provides in its Reply is that Muller's boron ion-implantation allegedly is beneficial "compared to a n-type-doped (phosphorous) ion-implanted FSF." Reply at 28 (emphasis added). Only Muller, and not Li, includes an n-typed-doped ion-implanted FSF. Thus, Petitioner's Reply underscores rather than refutes the point Patent Owner made in its Response, i.e., that Petitioner does not perform the proper comparison. Stated

⁸ Petitioner's citation to paragraph 106 of Dr. Carroll's declaration (Reply at 30) is inapposite. That paragraph does not support Petitioner's contention.

differently, Petitioner does not show that Muller's boron ion-implantation provides any benefits *relative to Li*.⁹

Petitioner finds no solace behind its allegation that Muller's process is "straightforward." Reply at 29. Whether "straightforward" or not, a skilled artisan is not motivated to make a modification unless they have determined it is "on balance, desirable." *Winner Int'l*, 202 F.3d at 1349. Petitioner failed to show that its proposed modifications of Li would have been.

III. CONCLUSION

The Board should confirm the patentability of the challenged claims.

Respectfully submitted,

Date: August 12, 2025

/Jacob A. Snodgrass/

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*Counsel for Patent Owner Maxeon Solar
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⁹ Petitioner cites Rohatgi (Ex. 1036) on page 29 of its Reply but fails to address Patent Owner's observations regarding that reference, i.e., that Rohatgi fails to compare ion-implantation to the process of Li. POR at 59.

CERTIFICATE OF WORD COUNT

Pursuant to 37 C.F.R. § 42.24(d), the undersigned certifies that this Patent Owner Sur-Reply, exclusive of the table of contents, table of authorities, certificate of service, certificate of word count, and list of exhibits, includes 5,567 words.

Pursuant to 37 C.F.R. § 42.24(d), Patent Owner relied on the word count feature of the word-processing system used to prepare this paper.

Date: August 12, 2025

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CERTIFICATE OF SERVICE

I certify that the foregoing Patent Owner's Sur-Reply was served on
Petitioner's counsel of record by electronic notification through P-TACTS and
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