

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

HANWHA SOLUTIONS CORPORATION,
Petitioner

v.

MAXEON SOLAR PTE. LTD.,
Patent Owner

Case IPR2024-01198
U.S. Patent No. 11,251,315

PATENT OWNER'S SUR-REPLY

TABLE OF CONTENTS

Table of Authorities	ii
Patent Owner’s Exhibit List.....	iv
I. Introduction.....	1
II. Claim Construction.....	1
A. Patent Owner’s Proposed Construction for “metal impurities” Is the Proper Plain and Ordinary Meaning.....	1
B. In the Alternative, Disclaimer Applies.....	7
III. Petitioner Has Not Shown that Any Challenged Claim Is Unpatentable.....	8
A. Petitioner’s Arguments with Respect to “metal impurities” Are Belated..	8
B. Petitioner Does Not Dispute that Choi and Cousins Fail to Disclose the “metal impurities” Limitation Under Patent Owner’s Proposed Construction.....	10
C. It Would Not Have Been Obvious to Combine Choi/Cousins with Istratov	10
1. Choi and Cousins Do Not Have Metal Contaminants That Require Gettering to a Polysilicon Layer	10
2. Istratov’s Process Would Be Detrimental to Choi and Cousins	15
D. Petitioner Fails to Show That It Would Have Been Obvious to Implement Choi or Cousins with the Claimed Dopant Concentration.....	17
1. Petitioner Continues to Misread Marvin	17
2. Petitioner Improperly Assumes That Choi and Cousins Have “well-passivated” Front Surfaces	19
3. There Is No Optimal Doping Concentration.....	21
E. It Would Not Have Been Obvious to Use a P-Type Dopant (For Example Boron) in Choi with All Other Claim Limitations	23
IV. Conclusion	26

TABLE OF AUTHORITIES**Cases**

<i>Affinity Labs of Texas, LLC v. Samsung Elecs. Co.</i> , No. 1:12-cv-557, 2014 WL 12605382 (E.D. Tex. June 4, 2014).....	6
<i>Aortic Innovations LLC v. Edwards Lifesciences Corp.</i> , No. 1:21-cv-1377, 2023 WL 7545328 (D. Del. May 9, 2023).....	7
<i>AstraZeneca AB v. Mylan Pharms. Inc.</i> , 19 F.4th 1325 (Fed. Cir. 2021)	4
<i>Baran v. Medical Device Techs., Inc.</i> , 616 F.3d 1309 (Fed. Cir. 2010)	2
<i>Boston Scientific Corp. v. Cook Inc.</i> , 187 F. Supp. 3d 249 (D. Mass. 2016).....	5
<i>Henny Penny Corp. v. Frymaster LLC</i> , 938 F.3d 1324 (Fed. Cir. 2019)	26
<i>Intelligent Bio-Systems, Inc. v. Illumina Cambridge Ltd.</i> , 821 F.3d 1359 (Fed. Cir. 2016)	25
<i>Luminara Worldwide, LLC v. Liown Elecs. Co. Ltd.</i> , 814 F.3d 1343 (Fed. Cir. 2016)	8
<i>Millennium Pharms., Inc. v. Sandoz Inc.</i> , 862 F.3d 1356 (Fed. Cir. 2017)	21
<i>Niazi Licensing Corp. v. St. Jude Medical S.C., Inc.</i> , 30 F.4th 1339 (Fed. Cir. 2022)	7
<i>Novartis Pharms. Corp. v. Accord Healthcare, Inc.</i> , 38 F.4th 1013 (Fed. Cir. 2022)	22
<i>Phillips v. AWH Corp.</i> , 415 F.3d 1303 (Fed. Cir. 2005) (en banc)	7, 8
<i>Tehrani v. Hamilton Med., Inc.</i> , 331 F.3d 1355 (Fed. Cir. 2003)	2
<i>Vivid Techs., Inc. v. Am. Sci. & Eng'g, Inc.</i> , 200 F.3d 795 (Fed. Cir. 1999)	6
<i>Wasica Fin. GmbH v. Cont'l Auto. Sys., Inc.</i> , 853 F.3d 1272 (Fed. Cir. 2017)	2

<i>Winner Int’l Royalty Corp. v. Wang</i> , 202 F.3d 1340 (Fed. Cir. 2000)	21
---	----

PATENT OWNER'S EXHIBIT LIST

Exhibit	Description
2001	Declaration of David Carroll, Ph.D. in Support of Patent Owner Preliminary Response
2002	Lamers et al., "Towards 21% Efficient N-CZ IBC based on Screen Printing," <i>26th European Photovoltaic Solar Energy Conference and Exhibition</i> , (2011)
2003	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)
2004	Pham et al., "Dopant-grading proposal for polysilicon passivating contact in crystalline silicon solar cells," <i>Journal of Power Sources</i> , 522, 2022
2005	Procel et al., "Analysis of the Impact of Doping Levels on Performance of Back Contact – Back Junction Solar Cells," 4th International Conference on Silicon Photovoltaics, SiliconPV 2014, Italy, 2014, pp 128-132, ScienceDirect
2006	Federal Court Management Statistics (September 30, 2024)
2007	<i>Intentionally Left Blank</i>
2008	<i>Intentionally Left Blank</i>
2009	Invalidity Contentions, <i>Maxeon Solar Pte. Ltd. v. Canadian Solar Inc.</i> , Case No. 2:24-cv-00210-JRG (E.D. Tex. Sept. 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	<i>Intentionally Left Blank</i>
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)

Exhibit	Description
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	<i>Intentionally Left Blank</i>
2021	Docket Sheet, <i>Maxeon Solar Pte. Ltd. v. Canadian Solar, Inc.</i> , Case No. 2:24-cv-00210-JRG (E.D. Tex.)
2022	Docket Sheet, <i>Maxeon Solar Pte. Ltd. v. Hanwha Solutions Corp.</i> , Case No. 2:24-cv-00262-JRG (E.D. Tex.)
2023	Docket Sheet, <i>Maxeon Solar Pte. Ltd. v. REC Solar Holdings AS</i> , Case No. 2:24-cv-00260-JRG (E.D. Tex.)
2024	Counterclaims, <i>Maxeon Solar Pte. Ltd. v. Hanwha Solutions Corp.</i> , Case No. 2:24-cv-00262-JRG (E.D. Tex. Nov. 15, 2024)
2025	Petition for <i>Inter Partes</i> Review, Paper 1, <i>Canadian Solar, Inc. v. Maxeon Solar Pte. Ltd.</i> , Case No. IPR2024-01038 (PTAB June 25, 2024)
2026	Petition for <i>Inter Partes</i> Review, Paper 1, <i>Canadian Solar, Inc. v. Maxeon Solar Pte. Ltd.</i> , Case No. IPR2024-01194 (PTAB July 19, 2024)
2027	Declaration of Dr. Mary K. Bolin <i>Served and Not Filed</i>
2028	Declaration of Fred Schubert, Ph.D. in Support of Patent Owner's Response
2029	<i>Curriculum Vitae</i> of Fred Schubert, Ph.D.
2030	McGraw-Hill Dictionary of Scientific and Technical Terms, 6th ed. (2003) (excerpts)
2031	Merriam-Webster's Collegiate Dictionary, 11th ed. (2006) (excerpts)
2032	<i>Intentionally Left Blank</i>
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, pp. 1163-1170
2034	Vossier, A., et al., “Is Auger Recombination the Ultimate Performance Limiter In Connector Solar Cells?” <i>Applied Physics Letters</i> 97, 193509 (2010)

Exhibit	Description
2035	Korte, L., et al., "Surface Photovoltage Investigation of Recombination at the a-Si/c-Si Heterojunction," Thin Solid Films 517, pp. 6396-6400 (2009)
2036	Cuevas, A., et al., "Extraction of the Surface Recombination Velocity of Passivated Phosphorous-Doped Silicon Emitters,"
2037	Transcript of deposition of Zachary Holman, Ph.D. taken May 1, 2025
2038	https://www.ioffe.ru/SVA/NSM/Semicond/Si/electric.html (accessed May 20, 2025)
2039	Declaration of Dr. Mary K. Bolin
2040 <i>New</i>	Transcript of deposition of Zachary Holman, Ph.D., taken September 12, 2025, with Errata

I. INTRODUCTION

Petitioner's Reply continuously sidesteps the most relevant evidence bearing on the parties' disputes. For example, with respect to the proper construction of "metal impurities," Petitioner glosses over the specification's clear disclosure equating impurities and contaminants but finds space for an indefiniteness argument inappropriate in an IPR. As another example, with respect to Dr. Holman's unequivocal testimony that "[g]ettering was only required in solar cells with significant metal impurity levels in the wafer," Petitioner states only that the testimony requires "context." However, instead of providing any "context" that would harmonize that position with its obviousness theories, Petitioner simply moves on. Also, apparently dissatisfied with its original evidence, Petitioner submitted *forty-eight* new exhibits with its Reply. However, this new evidence does not fill the holes exposed in Patent Owner's Response. Petitioner has failed to carry its burden: the patentability of the challenged claims should be affirmed.

II. CLAIM CONSTRUCTION

A. Patent Owner's Proposed Construction of "metal impurities" Is the Proper Plain and Ordinary Meaning

The '315 patent is clear: "contaminants and/or impurities can be used interchangeably." Ex. 1001, 5:9. Petitioner's feeble response is a suggestion that the word "interchangeable" does not convey an equivalency. Reply, p. 4. That is contrary to numerous Federal Circuit decisions. *E.g., Baran v. Medical Device*

Techs., Inc., 616 F.3d 1309, 1316 (Fed. Cir. 2010) (use of “two terms interchangeably” means the terms “have the same meaning”); *accord Wasica Fin. GmbH v. Cont'l Auto. Sys., Inc.*, 853 F.3d 1272, 1282 (Fed. Cir. 2017) (holding that use of terms “interchangeably” in a patent equates the terms); *Tehrani v. Hamilton Med., Inc.*, 331 F.3d 1355, 1361 (Fed. Cir. 2003) (same).

Petitioner's suggestion—indeed, it is only a suggestion because Petitioner stops short of actually making the argument—that the '315 patent may have redefined “contaminant” to include dopants is unavailing. *See* Reply, p. 4. The term “impurities” is subject to multiple interpretations; “contaminants” is not. Ex. 2028, ¶ 43. Further, none of the scores of references that Petitioner has introduced into the record uses “contaminants” to refer to dopants. Similarly, the '315 patent does not use “contaminant” to describe a dopant. In sum, the '315 patent did not redefine “contaminant” to a breadth never before seen.

The '315 patent is like many other publications that equate “impurities” with contaminants and treat dopants separately. Petitioner incorrectly alleges that “publications in the field **consistently** use ‘impurities’ to include intentionally introduced dopants.” Reply, pp. 2-3 (emphasis added). That contention is dispelled by many of Petitioner's references. For example, Exhibit 1047 recites that “the unintentional iron **contamination** level in wafers is usually higher than that of other metal **impurities**.” Ex. 1047, p. 489 (emphasis added); *see also id.*, p.

492, 501. Thus, Exhibit 1047 clearly understands impurities to cause contamination. By contrast, Exhibit 1047 does not use “impurities” to refer to dopants. *See* Ex. 2040, 71:9-18. The same is true with Exhibit 1033, which states, “[T]he material can be also unadvertently [sic] **contaminated** by metallic **impurities**.” Ex. 1033, p. 316 (emphasis added). Another example is Exhibit 1139, which states, “Our ICP-MS measurement results of metal **impurities** in mc-Si for solar cell applications have shown significant amounts of Cu and Ni **contamination**, partially higher than Fe, which is normally regarded as the most abundant metal **impurity** in such materials.” Ex. 1139, p. 192. Similarly, Exhibit 1031 discloses, “Highly doped (distorted) layers may act as sinks for impurities during gettering.” Ex. 1031, p. 72. Dr. Holman agrees that in that passage, the authors use “impurities” to refer to contaminants but not dopants. Ex. 2040, 104:20-105:10. None of the foregoing references above use “impurities” to refer to dopants.

Dr. Schubert's books do not support Petitioner. Indeed, that Dr. Schubert devoted a portion of the preface in his book “Doping in III-V Semiconductors” to the etymology of “impurities” reveals the dual meanings that the word can have. Specifically, Dr. Schubert noted that after the discovery that deliberately adding foreign atoms to semiconductors could yield beneficial results, but before the advent of the term “dopant,” the usage of term “impurities” was “broadened” to

have an “extended definition. Ex. 1105, p. 8. After the advent of the term “dopants,” an author had two choices: (i) use “impurities” to refer to all foreign atoms under the broadened definition, or (ii) use “impurities” to refer only to the deleterious foreign atoms (i.e., contaminants) and “dopants” to refer to intentionally-introduced atoms. In one of his books, Dr. Schubert chose the former and found it necessary to alert the reader in the preface of that book. The inventors of the ’315 patent chose the latter and manifested their choice through the written description.

Petitioner does not—and cannot—dispute that Patent Owner’s proposed construction is the only one consistent with a key purpose of the ’315 patent, i.e., to remove undesired material out of the substrate. As the Federal Circuit has explained, “the ordinary meaning of a claim term is not the meaning of the term in the abstract” but instead “its meaning to the ordinary artisan after reading the entire patent.” *AstraZeneca AB v. Mylan Pharms. Inc.*, 19 F.4th 1325, 1330 (Fed. Cir. 2021). While it ignores the purpose of the ’315 patent, Petitioner raises the specious argument that “[i]f the patentee intended to limit the claims to only ‘contaminants,’ it could have used that term in the claims.” Reply, p. 6. That is a non sequitur. Under Petitioner’s logic, no claim term should ever be construed. Specifically, Petitioner’s flawed logic dictates that any proposed construction must be rejected because the inventors could have recited the proposed construction in

the claims but did not. The large corpus of claim construction precedent dispenses with Petitioner's flawed proposition. Indeed, Petitioner's argument has been explicitly rejected. *Boston Scientific Corp. v. Cook Inc.*, 187 F. Supp. 3d 249, 259 (D. Mass. 2016).

Petitioner alleges to see evidence that does not exist when it invokes the prosecution history of the '315 patent's great-great-grandparent. Petitioner insists that the applicant in the ancestor application did not make a certain argument with respect to the prior art. Reply, p. 7. However, the record reveals the applicant disputed the Examiner's rejection¹ and believed the claims were allowable ***without amendment***. Ex. 1036, p. 83. Petitioner does not state what arguments it believed the applicant made, and its assertion that the applicant did not dispute the "metal impurities" limitation is without competent support. Petitioner cites Dr. Holman's declaration; however, he admitted that he has no knowledge regarding the arguments made by the applicant. Ex. 2040, 54:1-9. After the applicant unsuccessfully attempted to persuade the Examiner in an interview (based on arguments unknown to Petitioner), the applicant amended the claims to obtain allowance. Ex. 1036, pp. 85, 95, 97-98. The sparse evidence as to the great-great-

¹ The record does not indicate what in the applied reference the Examiner alleged corresponded to the "metal impurities" of the claim. Ex. 1036, p. 76.

grandparent application precludes a finding that the applicant clearly and obviously disclaimed subject matter. *See Affinity Labs of Texas, LLC v. Samsung Elecs. Co.*, No. 1:12-cv-557, 2014 WL 12605382, at *17 (E.D. Tex. June 4, 2014) (“[T]he patentee is not required to fight tooth and nail every possibly adverse thought an examiner commits to paper.”).

Petitioner's quasi-indefiniteness argument—which is improper in an Inter Partes Review proceeding—is unavailing. Petitioner argues that “the written description provides no guidance” as to the boundaries of “undesired” metals. Reply, p. 7. Petitioner is mistaken. Beyond providing exemplary metal impurities (all of which are undesired in a silicon substrate for solar cells), the specification notes that metal impurities/contaminants “can be detrimental to the electrical conduction of the solar cell” and “can be sources of recombination, resulting in poor lifetime, surface passivation and/or lower solar cell efficiency.” Ex. 1001, 4:65-5:5. A person of ordinary skill in the art would know which metals cause such problems with reasonable certainty. Ex. 2028, ¶ 42. In any event, all parties agree that iron—upon which Petitioner's theories invoking Istratov are based—is a contaminant for purposes of the '315 patent. Ex. 2040, 40:12-41:10. *See Vivid Techs., Inc. v. Am. Sci. & Eng'g, Inc.*, 200 F.3d 795, 803 (Fed. Cir. 1999) (holding that claim construction is required “only to the extent necessary to resolve the controversy”). Petitioner's complaint that the specification does not dictate the

precise concentrations at which contaminants cause problems is misdirected.

Reply, p. 7. The law does not impose such a requirement. *Niazi Licensing Corp. v. St. Jude Medical S.C., Inc.*, 30 F.4th 1339, 1347 (Fed. Cir. 2022) (holding that “mathematical precision” is not required to comply with definiteness requirement).

B. In the Alternative, Disclaimer Applies

Petitioner's Reply is the first instance in which it took the position that “contaminants” is not a plain and ordinary meaning of “impurities.” Although Petitioner is mistaken for the preceding reasons, even if it were correct, then the '315 patent clearly and unambiguously disclaimed the portion of “impurities” that covers dopants. “[T]he specification may reveal an intentional disclaimer, or disavowal, of claim scope by the inventor.” *Phillips v. AWH Corp.*, 415 F.3d 1303, 1316 (Fed. Cir. 2005) (en banc). Here, the inventors made clear that the term “impurities” was to have the same meaning as “contaminants.” The '315 patent states that “[a]s referred throughout, contaminants and/or impurities can be used interchangeably.” Ex. 1001, 5:8-9. Through this clear statement, the inventors manifested their intent that the terms have the same meaning. *See Aortic Innovations LLC v. Edwards Lifesciences Corp.*, No. 1:21-cv-1377, 2023 WL 7545328, at *10 (D. Del. May 9, 2023) (“[T]he inventor has acted as his own lexicographer to give the same definitions to [three terms] through consistent

interchangeable use of the terms.”). On the other hand, just as contaminants and dopants are mutually exclusive, “impurities” does not encompass dopants.

Petitioner misses the mark in arguing that Patent Owner does not “cite[] to the prosecution history as purported evidence of disavowal.” Reply, p. 4 n.2. The disavowal is found in the specification itself. *See Phillips*, 415 F.3d at 1316 (“[T]he **specification** may reveal an intentional disclaimer”); *see also Luminara Worldwide, LLC v. Liown Elecs. Co. Ltd.*, 814 F.3d 1343, 1353 (Fed. Cir. 2016) (finding disclaimer based on specification).

III. PETITIONER HAS NOT SHOWN THAT ANY CHALLENGED CLAIM IS UNPATENTABLE

Petitioner fails to show that either the “metal impurities” or doping concentration (“approximately less than or equal to $2 \times 10^{18} \text{ cm}^{-3}$ ”) limitations of claim 10 of the '315 patent are disclosed by or obvious in view of the cited references. Accordingly, all grounds fail.

A. Petitioner's Arguments with Respect to “metal impurities” Are Belated

Petitioner should not be rewarded for hiding its view as to the proper construction of “metal impurities” until its Reply. Petitioner does not, and cannot, dispute that the Petition's arguments with respect to the “metal impurities” limitations were buried under two contingencies, neither of which was satisfied. Instead, while sidestepping that issue, Petitioner erroneously contends that its

Petition addressed invalidity (i) under the plain and ordinary meaning of the term “metal impurities” and (ii) under “Maxeon’s incorrect construction.” Reply, p. 8. That is incorrect. With respect to the first contention, the Petition never stated what Petitioner believes the “plain and ordinary meaning” is. Indeed, the theories that do not rely on Istratov (and allege that Choi and Cousins themselves disclose “metal impurities”) were presented in anticipation of another argument that Patent Owner never made, i.e., “that the claimed invention includes any metal or any source of metal.” Petition, p. 54. With respect to the second contention, the Petition does not address Patent Owner’s construction at all. Instead, the fallback combinations with Istratov were presented in anticipation of an argument that Patent Owner never made, i.e., “that the claimed ‘metal impurities’ must be elements other than Group III or V elements.” Petition, p. 55.

Unable to change what it said in its Petition, Petitioner attacks a strawman. Specifically, Petitioner alleges that “the Petition’s arguments are not ‘contingent’ on any claim construction.” Reply, p. 8. In fact, the arguments are undeniably contingent on Patent Owner taking certain positions. It is equally undeniable that Patent Owner did not take either position.

Petitioner may have been hesitant to stake a position as to the scope of “metal impurities” because it wanted to maintain flexibility in the parallel litigation

between the parties. Regardless of its motivation, the Board should not

countenance Petitioner's delay in declaring its view as to the scope of the claims.

B. Petitioner Does Not Dispute that Choi and Cousins Fail to Disclose the “metal impurities” Limitation Under Patent Owner's Proposed Construction

A proper claim construction disposes of all grounds that are based on the contention that Choi or Cousins discloses the “metal impurities” limitation. POR, pp. 21-22. Petitioner does not dispute that.

C. It Would Not Have Been Obvious to Combine Choi/Cousins with Istratov

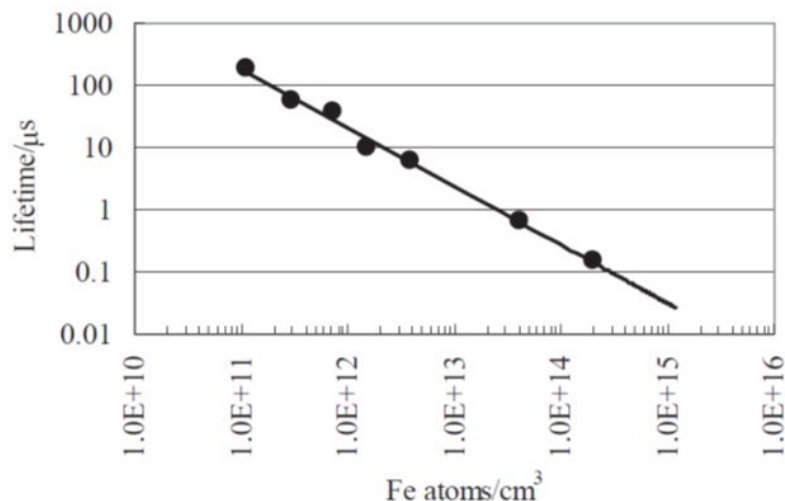
1. Choi and Cousins Do Not Have Metal Contaminants That Require Gettering to a Polysilicon Layer

At institution, the Board found that Petitioner had not adequately established that a POSITA would have combined Choi/Cousins with Istratov as proposed. Paper 17, pp. 21, 28. Petitioner has not meaningfully supplemented the record since. Instead, rather than address the concerns of the Board, Petitioner continues to assert, without adequate justification, that a POSITA would have been motivated to expel iron impurities from the substrate of Choi or Cousins. In effect, Petitioner assumes what it has the burden to prove.

Petitioner fails to rebut Patent Owner's observation that Choi and Cousins fail to disclose that their respective substrates include impurities that should be gettered. Instead, Petitioner devotes a large section of its Reply to the proposition

that “silicon solar cells had metal impurities that needed to be gettered.” Reply, p.

10. If Petitioner means that *some* silicon solar cells suffered from that problem, that contention is irrelevant because it would not have been obvious to implement gettering in Choi or in Cousins simply because other solar cells might benefit from that process. If Petitioner means that *all* silicon solar cells required gettering, that new argument is incorrect. Indeed, Cousins discloses a substrate with miniscule levels of iron impurities. Specifically, Cousins discloses that its silicon wafer has a “long lifetime,” for example, a lifetime of 2 to 5 milliseconds. Ex. 1007, 2:44-46. According to references that Petitioner introduced in this proceeding, such lifetimes are achieved with silicon having extremely low contaminant levels. Specifically, according to Petitioner's Exhibit 1139, there is a direct relationship between lifetime and iron contamination concentrations:



Ex. 1139, p. 189 (Fig. 7).

The lifetimes achieved by Cousins are greater than anything represented on the graphs above. In particular, the maximum lifetime shown in Exhibit 1139 is for iron concentrations of $1 \times 10^{11} \text{ cm}^{-3}$, and the corresponding lifetime is approximately 200 μs (or 0.2 milliseconds). By contrast, Cousins discloses a lifetime of 2 to 5 milliseconds. This means that Exhibit 1139 suggests iron contamination in Cousins far less than $1 \times 10^{11} \text{ cm}^{-3}$.² Petitioner utterly fails to show that there would have been any benefit in trying to remove the few iron atoms that exist in those circumstances.

For similar reasons, Petitioner's attempt to brush aside Choi's failure to disclose impurities as "no surprise" falls flat. Reply, p. 11. Choi could have as pure a substrate as Cousins. Certainly, it is not necessary that Choi have "significant metal impurity levels," such that gettering would be required or even desired. *See* Ex. 1003, ¶ 83. Indeed, Petitioner does not advance an inherency argument. *See* Ex. 2037, 91:21-92:3 (Dr. Holman conceding he did not opine Choi and Cousins necessarily include metal contaminants); Ex. 2040, 125:8-126:6 (same).

² Petitioner's Exhibit 1119 suggests a similarly miniscule iron concentration in Cousins. Ex. 1119, p. 95 (Fig. 3.7).

Petitioner's expert was right when he said, "Gettering was *only* required in solar cells with *significant* metal impurity levels in the wafer." Ex. 1003, ¶ 83 (emphasis added). Petitioner alleges that Patent Owner reads Dr. Holman's testimony "out of context," Reply, p. 12, but fails to explain what the proper context was. Regardless, there is no "context" that can rewrite Dr. Holman's testimony. In this regard, Petitioner's allegation that Dr. Schubert lacks the experience of Dr. Holman is both curious and baseless. Reply, pp. 1-2. It is curious because Dr. Holman's testimony undermines Petitioner's obviousness theories. Thus, the more it is credited, the less sound Petitioner's theories are. It is baseless because Dr. Schubert's credentials—both captured in his CV and explored during his deposition—more than meet those of Dr. Holman. Notably, Dr. Holman does not share Petitioner's view that he is more experienced. Ex. 2040, 17:5-18:7. Indeed, Dr. Holman admitted that he *has never designed* a diffused front surface field, which is a feature central to the parties' dispute regarding the "dopant concentration" limitation. Ex. 2037, 131:17-22; Ex. 2040, 19:3-17. Dr. Schubert *has designed* front surface fields. Ex. 1090, 27:19-28:4, 35:9-36:9, 37:9-20.

Petitioner misrepresents the testimony of Patent Owner's expert from another proceeding. Specifically, Petitioner alleges that Dr. David Carroll admitted that gettering was "necessary" during solar cell fabrication. Reply, p. 12. In fact, he testified to the contrary. Dr. Carroll stated that a broad range of silicon

substrates are, and were, available. Thus, after stating that low-quality (and low-cost) silicon can be used to make a solar cell, Dr. Carroll testified:

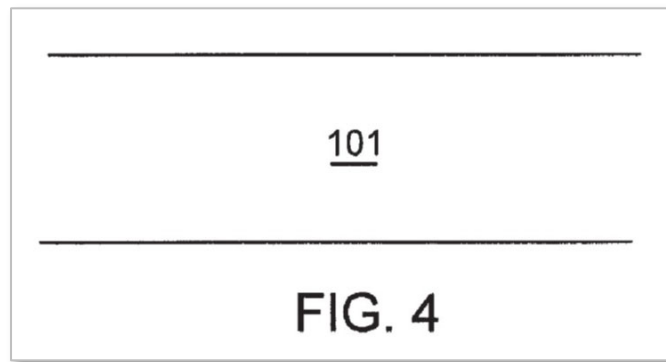
You don't have to do that. You can use the higher-quality stuff, but it will cost you more.

Ex. 1092, 25:17-18.

Dr. Carroll also testified that “gettering” includes numerous techniques that do not result in impurities travelling to a polysilicon layer. For example, Dr. Carroll testified that “gettering” includes introducing atoms to interact with contaminants and “raise the level – the energy level of the impurity in the band structure of the substrate . . . so that it no longer affects the carrier.” *Id.*, 113:13-19. Even though the impurity is not removed, Dr. Carroll explained “[t]hat too is gettering, because it is *effectively* gone.” *Id.*, 113:19-20 (emphasis added). Dr. Holman agreed. Ex. 2040, 115:17-116:6. Also, Dr. Carroll explained that impurities may be gettered out of a substrate and then become trapped in impurity sinks (such as interfaces between layers) before they reach a polysilicon layer. Ex. 1091, ¶¶ 57-61. Again, Dr. Holman agreed. Ex. 2040, 116:7-18. Thus, Petitioner's suggestion that gettering, even if employed, will necessarily result in transferring impurities to a polysilicon layer is mistaken.

Cousins's disclosure of a “cleaning” step does not aid Petitioner. *See Reply*, p. 29. The step removes metal contamination on the surface of the wafer resulting

from sawing the wafer from its ingot. Ex. 1007, 4:23-34. That process does not involve gettering and is performed before the polysilicon layer 108 (which Petitioner alleges corresponds to the claimed “first emitter region”) is created. Rather, the cleaning step is performed on silicon substrate 101 depicted in Figure 4, prior to the application of any other layer.



Ex. 1007, Fig. 4. Necessarily, any impurities that are removed during the cleaning step cannot end up in Cousins's polysilicon emitters. Dr. Holman agrees. Ex. 2040, 140:4-141:10.

2. *Istratov's Process Would Be Detrimental to Choi and Cousins*

Petitioner does not show the existence of a time-temperature combination that would have both (i) gettered metal impurities from the substrate of either Choi and Cousins to a polysilicon layer in those references and (ii) not have had determinantal effects that outweigh any perceived benefits. Indeed, Dr. Holman fails to provide a single exemplary time-temperature combination for use in either

Choi or Cousins notwithstanding his opinion that making such a determination would have been “routine.” Ex. 2040, 168:15-169:5.

Petitioner's reliance on section 3 of Istratov is misplaced. In that section, Istratov does not teach a practical means of purifying a silicon substrate. Rather, in that section, Istratov performed an experiment solely to determine or validate certain material properties for use in its gettering models. Specifically, Istratov discloses as follows:

To perform predictive modelling of gettering, we performed several experiments to determine or verify the materials parameters essential for correct quantitative description of the processes involved in gettering of metals in SOI wafers.

Ex. 1012, pp. 569-70.

Thus, Istratov employed a protracted 8-hour heat treatment at 1020°C to ensure that “equilibrium” was obtained. Ex. 1012, p. 570. Istratov does not suggest that time-temperature combination serves as a starting point from which others may calibrate a different suitable pairing. Further, Petitioner's assumption that a reduction in the thickness of an oxide will allow for diffusion at shorter times and/or lower temperatures is unsupported. *See Reply*, p. 17. The interfaces at either side of the oxide layer act as sinks for impurities. Dr. Holman agrees. Ex. 2040, 116:7-18. Those interfaces will trap impurities regardless of the thickness of the oxide.

D. Petitioner Fails to Show That It Would Have Been Obvious to Implement Choi or Cousins with the Claimed Dopant Concentration

1. Petitioner Continues to Misread Marvin

Petitioner continues to fail to understand one of the key references in its obviousness combinations. Petitioner's obviousness theories are premised on a terrestrial application of Choi and Cousins. Reply, p. 18. Marvin discloses that a doping concentration of $5 \times 10^{18} \text{ cm}^{-3}$ should be used in that scenario. Specifically, in its Conclusion section, Marvin teaches that in a "low radiation environment," the front surface field "should be an approximately 0.5 μm step with doping concentration of $5\text{E}18 \text{ cm}^{-3}$." Ex. 1008, p. 25. Marvin makes clear that a terrestrial environment is one example of a low radiation environment. *Id.*, p. 16. Dr. Holman agrees. Ex. 2040, 169:14-170:2.

Petitioner lodges a curious complaint when it states that Patent Owner relies on disclosure related to space missions. Reply, p. 18. Marvin, a reference upon which Petitioner chose to base its obviousness theories, is directed at space applications. Marvin's title betrays its focus: "Interdigitated Back Contact Silicon Solar Cell Analysis and Design Recommendations *for Space Use*." Ex. 1008, p. 1 (emphasis added). The portion of Marvin upon which Patent Owner relies is the only portion that relates to a terrestrial application. Specifically, Patent Owner relies on disclosure relating to a "low radiation environment," which could be (i)

space-based and shielded or (ii) terrestrial. Indeed, the sole appearance that the word “terrestrial” makes in Marvin is at the following: “In cases where radiation exposure is not present as the result of shielding or *terrestrial use* . . .” Ex. 1008, p. 16. Thus, that the “low radiation environment” discussed in the conclusion of Marvin would also apply to a space mission where shielding is employed does not lessen the applicability of that same section to a terrestrial environment.

Petitioner's contention that Marvin's space-related disclosures are inapplicable to its obviousness theory defeats its own argument. The disclosure on page 15 of Marvin—upon which Petitioner relies—relates to space-based applications. As Dr. Schubert explained, the scope of Marvin's study is “to evaluate the usefulness of IBC solar cells in space applications.” Ex. 1090, 170:18-171:21; *accord id.*, 178:9-179:10. Further, the passage regarding “BOL” (Beginning Of Life) upon which Petitioner focuses makes sense only in a space-based application. BOL and EOL (End Of Life) are concepts that apply only in space-based applications. When a solar cell is outside the protective shield of the Earth's atmosphere, its performance degrades over time, as Dr. Holman affirms. Ex. 2040, 177:3-9. Thus, the simulations in Marvin for BOL and EOL—including those on page 15—are for a space-based application.

Petitioner again defeats its own argument when it attempts to explain away the “baseline cell geometry” passage on page 15 of Marvin. Petitioner disputes

that the doping concentration of $1 \times 10^{17} - 1 \times 10^{18} \text{ cm}^{-3}$ is applicable only for the specific parameters set forth in Table 2 of Marvin. Reply, p. 20. Petitioner asserts that “[v]arying the thicknesses of the carrier collections regions would not affect the FSF.” Reply, p. 20. If that is true, then the doping concentration range of $1 \times 10^{17} - 1 \times 10^{18} \text{ cm}^{-3}$ would not be applicable for any terrestrial applications, even for the specific design conditions of the baseline cell geometry. Stated differently, under Petitioner’s view, the range of $1 \times 10^{17} - 1 \times 10^{18} \text{ cm}^{-3}$ is preferred for all high-radiation space environments, and the value of $5 \times 10^{18} \text{ cm}^{-3}$ is preferred for all terrestrial applications, regardless of the dimensions of the back side of the solar cell.

2. *Petitioner Improperly Assumes That Choi and Cousins Have “well-passivated” Front Surfaces*

Petitioner makes unsupported assumptions to explain away evidence—including Granek—that undermines its theory. Specifically, Petitioner insists that the solar cells of Choi and Cousins have “well-passivated front surfaces with [surface recombination velocities] below 500 cm/s.” Reply, p. 22. None of the citations that follow support that contention. Dr. Schubert testified only that Choi and Cousins disclose passivated surfaces; he did not state that such surfaces were well-passivated, poorly-passivated, or something between. The remaining references do not shed any additional light on the issue. Aberle-2000 examines recombination velocities of (a) 10 cm/s, (b) 1,000 cm/s, and (c) 100,000 cm/s. Ex.

1118, p. 474. The reference does not suggest that the solar cells of Choi or Cousins have the lowest of those values. Hermle discloses only that “excellent” passivation velocities of below 10 cm/s may be achieved, but it also examines recombination velocities of 1,000,000 cm/s. Ex. 1041, p. 2 (Fig. 2). Similarly, Marvin performed certain simulations assuming an “excellent passivation” of less than 10 cm/s. However, Marvin does not suggest that a solar cell similar to that of Choi or Cousins necessarily would have had that recombination velocity. Indeed, Marvin’s baseline parameter is 1,000 cm/s. Ex. 1008, p. 26. Although Petitioner does not cite its expert to support its contention, Dr. Holman believes Choi and Cousins have “well-passivated” surfaces only because they provide, as examples of a passivated surface, silicon dioxide and silicon nitride. Ex. 2040, 195:20-196:7. That fails. A “typical” front surface recombination velocity was 1,000 cm/s “for an *oxide-covered c*-Si surface.” Ex. 2035, p. 6397 (emphasis added).

In this regard, Petitioner does not dispute either that 1,000 cm/s was a common recombination velocity in 2014 or Dr. Schubert’s testimony that decreasing the velocity would have been expensive. *See* Ex. 2028, ¶ 87. Petitioner also does not dispute Dr. Schubert’s testimony that the differences between the simulation results of Figure 7-1 of Granek for $1 \times 10^{18} \text{ cm}^{-3}$ and $1 \times 10^{19} \text{ cm}^{-3}$ at low surface recombination velocities are “likely smaller than the unavoidable uncertainties associated with [Granek’s] simulation.” Ex. 2028, ¶ 84; *see also* Ex.

1090, 195:12-197:15, 212:11-18. Perhaps for these reasons, Petitioner does not argue that it would have been obvious to implement Choi or Cousins with “excellent” passivation. Had Petitioner proceeded down that path, it would have had to show that the benefits in doing so justified the expense. *Winner Int’l Royalty Corp. v. Wang*, 202 F.3d 1340, 1349 (Fed. Cir. 2000) (“Trade-offs often concern what is feasible, not what is, on balance, desirable. Motivation to combine requires the latter.”). Instead of trying to make such a showing, Petitioner assumes that Choi and Cousins necessarily would have had a “well-passivated” surface. That assumption lacks a proper basis. *See Millennium Pharms., Inc. v. Sandoz Inc.*, 862 F.3d 1356, 1367 (Fed. Cir. 2017) (“The mere fact that a certain thing may result from a given set of circumstances is not sufficient to render the result inherent.”).

3. *There Is No Optimal Doping Concentration*

Petitioner proves Patent Owner’s point when it argues that the doping concentrations of Lamers, Procel, and Desa may not be ideal for Choi or Cousins. Reply, pp. 24-25. Patent Owner discussed those references to support the proposition that there is no single doping concentration that is optimal across all potential implementations. POR, pp. 42-46. Petitioner appears to agree when it alleges that those references show that different doping concentrations are appropriate under different circumstances. Reply, pp. 24-25. The same applies for

the doping concentrations that Petitioner has found in other references—just because they were used in other implementations does not mean they would have been obvious to employ in Choi or Cousins.

Petitioner commits additional errors in attempting to distinguish the references. With respect to Lamers, Petitioner contends that lateral function is not a function of Choi's FSF based merely on Choi's failure to explicitly state so. However, the absence of disclosure is not disclosure. *Cf. Novartis Pharms. Corp. v. Accord Healthcare, Inc.*, 38 F.4th 1013, 1017 (Fed. Cir. 2022) ("Silence is generally not disclosure."). Further, Petitioner overlooks the words of Granek. The only instance in which Granek assigns a value to the phrase "lightly doped" is on page 46 where it states that $5 \times 10^{18} \text{ cm}^{-3}$ is "lightly doped." Ex. 1010, p. 46. Dr. Holman concurs. Ex. 2040, 189:1-190:8. Petitioner attempts to distract by relying on disclosure of "lowly doped"—which are *not* the words used in Lamers. Petitioner apparently reads "lightly doped" and "lowly doped" to have the same meaning; however, there is no indication in Granek that the two are interchangeable. Without any legitimate basis to treat the different phrases to mean the same thing, Dr. Holman slights Granek as "not a native English speaker." Ex. 2040, 192:10-11.

Petitioner also undermines its own obvious argument in an effort to distinguish Dessa. Petitioner complains that Desa uses the term "front surface

field” to refer to an arrangement where the dopant has a polarity opposite to the substrate. Reply, p. 25. Yet, in the two pages following, Petitioner argues that Granek’s teachings with respect to phosphorous (an N-type dopant) in an N-type substrate extend to a P-type FSF. Reply, pp. 26-27. Both positions cannot be correct.

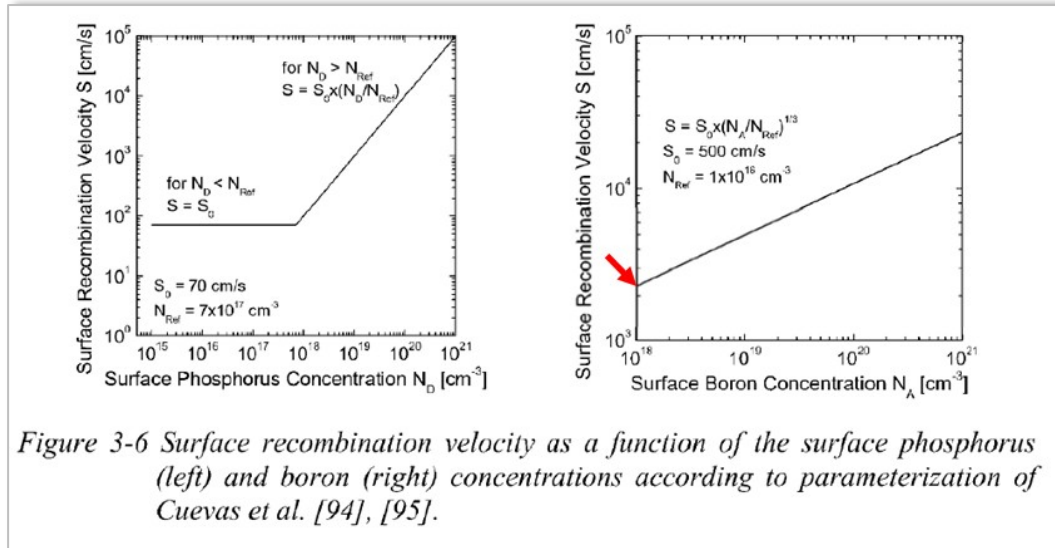
Petitioner defeats its own argument yet again when it states, with respect to Procel, that the parameters of the rear and front regions of a solar cell can be optimized separately. Reply, p. 25. Among the two Procel exhibits in this matter, only Exhibit 2005 examines optimal dopant concentrations for the front region. By contrast, Exhibit 1040 focuses on optimizing geometry on a back side (opposite the FSF side). Ex. 1040, p. 15. According to Petitioner, those endeavors are able to proceed independently from each other. Thus, the dopant concentration of the front surface field of Exhibit 1040 is not an indication as to what the authors of Exhibit 1040 thought was an optimal doping concentration. Indeed, Dr. Holman conceded that the results of Exhibit 1040 would have been the same if Exhibit 1040 used the optimum values discovered in Procel (Ex. 2005). Ex. 2040, 220:1-19.

E. It Would Not Have Been Obvious to Use a P-Type Dopant (For Example Boron) in Choi with All Other Claim Limitations

Petitioner sidesteps the central issue with respect to claims 13 and 14. While Petitioner alleges that “the relationship between dopant concentration, SRV

[surface recombination velocity], and emitter saturation current density for boron and phosphorus was well-understood by 1990,” Petitioner fails to show how that relationship would have led a POSITA to choose boron as a dopant and in the claimed concentration range.

Indeed, the phosphorous-specific signposts upon which Petitioner relies (albeit erroneously for the reasons stated previously) do not apply for claims 13 and 14. The former are specific to an N-type dopant, and the latter require a P-type dopant. For example, Petitioner contends that “Maxeon ignores that Granek’s Figure 3-6 shows a dopant concentration of $1 \times 10^{18} \text{ cm}^{-3}$ would result in an SRV of 100 cm/s.” Reply, p. 22. However, putting aside the inaccuracies of that model that have already been discussed (*see* POR at 38-41), Figure 3-6 shows that a doping concentration of $1 \times 10^{18} \text{ cm}^{-3}$ for boron would result in an SRV of well over 2,000 cm/s.



Ex. 1010, p. 42 (Fig. 3-6) (annotated). Per the equation provided by Granek, the surface recombination velocity is approximately 2,320 cm/s ($S = 500 \text{ cm/s} \times (100)^{1/3} = 2,320.8 \text{ cm/s}$). Ex. 1010, p. 42; *see also* Ex. 2040, 206:5-10 (Dr. Holman conceding the foregoing equation is correct). At such a level, even the problematic modelling reflected at Figure 7-1 of Granek reveals that a doping concentration of $1 \times 10^{19} \text{ cm}^{-3}$ is superior to a doping concentration of $1 \times 10^{18} \text{ cm}^{-3}$. Ex. 1010, p. 121.

Petitioner attempts to side-step Granek's Figure 3-6 by vaguely stating that "low SRVs could be achieved with both n- and p-type silicon." Reply, pp. 26-27. The only support Petitioner offers is a new theory from Dr. Holman, which is premised on using aluminum oxide as a passivating layer. The Board need not consider Petitioner's belated theory. *Intelligent Bio-Systems, Inc. v. Illumina Cambridge Ltd.*, 821 F.3d 1359, 1369 (Fed. Cir. 2016). Neither "aluminum oxide" nor " Al_2O_3 " appear in the Petition. Further, Dr. Holman concedes that Cousins

does not disclose an aluminum oxide passivating layer, and Dr. Holman also concedes that he is not relying on the only embodiment of Choi that discloses such a layer (as that embodiment fails to include a front surface field). Ex. 2040, 201:20-202:10, 203:13-205:7.

Petitioner continues to ignore the drawbacks that would attend a switch from an N-type substrate to a P-type substrate. Granek itself lists the benefits of the former, and Dr. Holman concurs. Ex. 2037, 79:11-21. Petitioner silence defeats its argument. *See Henny Penny Corp. v. Frymaster LLC*, 938 F.3d 1324, 1332 (Fed. Cir. 2019) (holding that in an obviousness inquiry “the benefits, ***both lost and gained***, should be weighed against one another”).

IV. CONCLUSION

The Board should confirm the patentability of the challenged claims.

Respectfully submitted,

Date: September 25, 2025

/Jacob A. Snodgrass/

Jacob A. Snodgrass (Reg. No. 66,032)

*Counsel for Patent Owner Maxeon Solar
Pte. Ltd.*

CERTIFICATE OF WORD COUNT

Pursuant to 37 C.F.R. § 42.24(d), the undersigned certifies that this Patent Owner's Sur-Reply, exclusive of the table of contents, table of authorities, certificate of service, certificate of word count, and list of exhibits, includes 5,575 words. Pursuant to 37 C.F.R. § 42.24(d), Patent Owner has relied on the word count feature of the word-processing system used to prepare this paper.

Date: September 25, 2025

/Jacob A. Snodgrass/

Jacob A. Snodgrass (Reg. No. 66,032)

*Counsel for Patent Owner Maxeon
Solar Pte. Ltd.*

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
email to:

David Cavanaugh (David.Cavanaugh@wilmerhale.com)
Mark Selwyn (Mark.Selwyn@wilmerhale.com)
John Hobgood (John.Hobgood@wilmerhale.com)
Jorge Kina (Jorge.Kina@wilmerhale.com)
Abigail Lubow (Abigail.Lubow@wilmerhale.com)
Robert Stiller (Robert.Stiller@wilmerhale.com)
Nora Xu (Nora.Xu@wilmerhale.com)
Alexander J. Nemtzow (Alex.Nemtzw@wilmerhale.com)
Gilbert Smolenski (Gilbert.Smolenski@wilmerhale.com)
WHMaxeonIPRService@wilmerhale.com

Date: September 25, 2025

/Jacob A. Snodgrass/

Jacob A. Snodgrass (Reg. No. 66,032)

*Counsel for Patent Owner Maxeon
Solar Pte. Ltd.*