

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 No. IPR2024-01198

U.S. Patent No. 11,251,315

PETITIONER'S REPLY

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I. INTRODUCTION

Maxeon's Patent Owner Response ("POR") fails to rebut Petitioner's evidence.

First, Maxeon's proposal to limit the meaning of "metal impurities" to "undesired foreign metals," in order to cover only contaminants and exclude dopants, is contrary to plain and ordinary meaning, as numerous technical dictionaries and textbooks confirm. Maxeon does not argue lexicography exists to confer unusual meaning to "metal impurities," and the intrinsic evidence confirms the patent did not exclude dopants from the term's ordinary meaning.

Second, obviousness does not require a motivation to be expressly lifted from the references sought to be combined; it can be based on known problems in the field. Here, the motivation to implement Istratov's gettering in Choi's solar cell is premised on problems caused by metal impurities known in the field by 2014. Indeed, Maxeon's original expert, Dr. Carroll, admitted that "gettering" was "necessary" because the solar industry in 2014 used "lower[-]quality silicon" wafers with typical metal impurity concentrations "greater than" 10^{15} cm^{-3} . Ex.1092-Carroll-CSI-Tr., 25:2-27:4, 29:3-14. While Maxeon's new expert, Dr. Schubert, disagrees with Dr. Carroll, he offers no credible support for his position—perhaps because he lacks the solar design experience of Dr. Carroll or Petitioner's expert,

Dr. Holman.

Third, Maxeon misreads Marvin and asserts that Granek does not teach the claimed dopant concentration is preferred. But Maxeon does not dispute that both references (and numerous others) teach the claimed dopant concentration is a suitable option, which is all the law requires.

II. “METAL IMPURITIES” SHOULD BE GIVEN ITS PLAIN AND ORDINARY MEANING

As the Petition explains, no claim construction is necessary because the issues can be resolved based on plain and ordinary meaning of “metal impurities.” Pet., 24. Maxeon’s attempt to narrowly construe “metal impurities” to avoid prior art should be rejected.

“Impurities” has a single plain and ordinary meaning in the semiconductor/solar field.¹ A POSITA in 2014 would have understood the plain and ordinary meaning of “impurities” to be any element that is foreign to the element(s) of a host material, including intentionally-introduced dopants. Technical dictionaries give “impurities” this meaning in the semiconductor field, *e.g.*, Ex.1108-EE-Dictionary, 299; Ex.1109-Wiley-Dictionary, 363-64, and publications

¹ The semiconductor and solar fields are closely related and share terminology.

Infra p. 13.

in the field consistently use “impurities” to include intentionally introduced dopants. Dr. Schubert’s own textbook explains “the term ‘impurities’ is used for unintentional as well as intentional foreign atoms in a semiconductor.” Ex.1105-Schubert-1993, xvi. Another Schubert textbook describes “dopants” as “impurities.” Ex.1106-Schubert-1996, 3-4. Other textbooks use “impurities” to include intentionally introduced dopants. *E.g.*, Ex.1107-Streetman, 81. While Maxeon cites a technical dictionary that gives a general definition of “impurity” as “[a]n undesirable foreign material in a pure substance” (POR, 14), the same dictionary provides a definition *specific to the semiconductor field* that includes dopants. Ex.2030-McGraw-Hill-Dictionary; *see also* Ex.1090-Schubert-Tr., 76:9-12, 77:12-16; Ex.1089-Reply-Decl., ¶¶21-27.

Maxeon’s assertion that “impurities” requires construction because it “has more than one plain and ordinary meaning” (POR, 14), is wrong. Neither Maxeon nor Dr. Schubert identifies *any* reference giving “impurities” Maxeon’s proposed construction in the semiconductor field, and the intrinsic evidence does not support Maxeon’s attempt to replace the plain and ordinary meaning of “impurities” with the

definition of “contaminants.” *Id.*² Maxeon principally relies on the specification’s statement that “[a]s referred throughout, contaminants and/or impurities can be used interchangeably” (Ex.1001-USP315, 5:8-9), but fails to explain why that means “impurities” should be replaced by “contaminants,” and not, for example, the other way around. Further, Maxeon’s one-way substitution is inconsistent with the meaning of “interchangeable,” which is that *either* word may be used where one appears. Moreover, the specification repeatedly refers to “impurities and/or

² Maxeon does not argue the patentee acted as its own lexicographer, and while Dr. Schubert refused to directly answer whether the ’315 patent expressly defines “impurities,” Ex.1090-Schubert-Tr., 80:19-83:6, his declaration only purports to apply a “plain and ordinary” meaning. Ex.2028-Schubert-Decl., ¶44. Further, while Dr. Schubert offers an opinion regarding “disclaimer,” Ex.2028-Schubert-Decl., ¶54, Maxeon’s POR does not cite that paragraph or otherwise argue disavowal; neither Maxeon nor Dr. Schubert cites to the prosecution history as purported evidence of disavowal. Accordingly, the only dispute is the plain and ordinary meaning of “impurities.” *Luminara Worldwide, LLC v. Liown Elecs. Co.*, 814 F.3d 1343, 1353 (Fed. Cir. 2016) (“Absent lexicography or disavowal, we do not depart from the plain meaning of the claims.”); Ex.1089-Reply-Decl., ¶¶31-32, 35.

contaminants.” *E.g.*, Ex.1001-USP315, 4:66, 6:57-58, 7:48. Use of “A and/or B” is generally understood to include “A alone,” “B alone,” and “both A and B.” *See Cochlear Bone Anchored Sol’ns AB v. Oticon Medical AB*, 958 F.3d 1348, 1359-60 (Fed. Cir. 2020). Using “and/or” is extraneous if impurities is limited to only “contaminants.” Ex.1089-Reply-Decl., ¶¶28-30.

Maxeon’s reliance on reference numbers in the ’315 patent’s drawings to support the “interchangeability of ‘impurities’ and ‘contaminants’” (POR, 15-16) is also unavailing. It is undisputed that contaminants are a subset of impurities. Ex.1090-Schubert-Tr., 50:10-51:13. Thus, references to “contaminants” as examples of “impurities” do not demonstrate clear intent to depart from plain and ordinary meaning, and the specification’s inconsistent use of “contaminants,” “impurities,” and “contaminants and/or impurities” confirms the patentee did not intend to redefine “impurities” as “contaminants.” *Kyocera Senco Indus. Tools Inc. v. Int’l Trade Comm’n*, 22 F.4th 1369, 1378 (Fed. Cir. 2022) (“To act as its own lexicographer, a patentee must clearly set forth a definition of the disputed claim term other than its plain and ordinary meaning and must clearly express an intent to redefine the term.”). Similarly, Figure 1’s reference to both “contaminants” and “dopants” does not support Maxeon’s proposed construction (POR, 16), as contaminants and dopants are both subsets of impurities. If anything, it demonstrates

that the patentee knew how to distinguish between impurities that behave as dopants and impurities that may be contaminants when it intended to do so. Ex.1089-Reply-Decl., ¶¶33-34.

If the patentee intended to limit the claims to only “contaminants,” it could have used that term in the claims. Instead, the patentee claimed “metal impurities.” Maxeon asserts that its proposed construction “is consistent with a key aspect of the ’315 patent” of gettering contaminants “from a substrate...into an emitter region” (POR, 15), but the claims neither recite gettering nor require that the metal impurities originate from the substrate. Even under Maxeon’s construction, claim 10 would not require gettering “undesired foreign metals” from the substrate. Ex.1089-Reply-Decl., ¶37.³

The prosecution history also demonstrates the patentee did not intend to disclaim dopants from “impurities.” During prosecution of U.S. 9,520,507 (the ’315

³ Dr. Schubert could not identify any language in the claims requiring gettering but nevertheless insisted “there is a gettering process.” Ex.1090-Schubert-Tr., 84:9-89:7. Such importation of limitations into the claims from the specification is improper. *Resonate Inc. v. Alteon Websystems, Inc.*, 338 F.3d 1360, 1364-65 (Fed. Cir. 2003).

patent's parent), the Examiner rejected claims reciting "a first emitter region having metal impurities" based on Yelundur, which discloses an emitter doped with the same metallic dopants as Choi. Ex.1110-Yelundur, [0053], [0055]; *see also* Ex.1036-USPA935FH, 39, 76. The patentee did not respond that Yelundur lacks the claimed "metal impurities" but instead added a new claim limitation to avoid the prior art. Ex.1036-USPA935FH, 98; Ex.1089-Reply-Decl., ¶36.⁴

Finally, Maxeon's construction would render the claims indefinite. The specification provides only an exemplary list of "metal impurities" and fails to provide any objective boundaries for a POSITA to know what constitutes an "undesired" metal within the claims. Ex.1001-USP315, 4:65-5:1. Dr. Holman explained that even dopants may be desirable or undesirable depending on the concentration, Ex.2037-Holman-Tr., 125:7-21, and Dr. Schubert agrees. Ex.1090-Schubert-Tr., 53:19-54:6. But the written description provides no guidance at what concentration a dopant becomes "undesired" under Maxeon's construction. Therefore, the claims would not inform a POSITA of the scope of the invention with reasonable certainty. Ex.1089-Reply-Decl., ¶¶38-39.

⁴ Dr. Schubert did not consider the prosecution history of the '507 patent. Ex.2028-Schubert-Decl., ¶19; Ex.1090-Schubert-Tr., 26:18-27:4.

III. CLAIMS 10-17, 19-20 ARE OBVIOUS OVER CHOI, GRANEK OR MARVIN, AND OPTIONALLY ISTRATOV (GROUND I)

A. Choi Discloses Emitter Regions Having “Metal Impurities”

Maxeon's only argument regarding Choi's disclosure of first and second emitters having metal impurities is based on its proposed construction of “metal impurities.” POR, 21-22, 48. It does not dispute that Choi discloses foreign metallic elements in its first and second conductive type areas 32 and 34. As the Petition explains, Choi discloses first and second emitter regions having metal impurities under the plain and ordinary meaning of “metal impurities.” Pet., 54-55, 59; Ex.1089-Reply-Decl., ¶¶41-43.

Unable to support its construction of “metal impurities,” Maxeon advances a meritless procedural argument that the Board should disregard the Petition's grounds and arguments because the Petition demonstrates invalidity under *both* the plain and ordinary meaning of “metal impurities” *and* Maxeon's incorrect construction. Maxeon's attempt to avoid the Petition's substantive arguments should be rejected.

The Petition's arguments are not “contingent” on any claim construction. POR, 19. The Petition states that “[c]laim construction is not necessary,” Pet., 24; its arguments cannot be contingent on an unnecessary construction. Instead, the Petition anticipated Maxeon's present attempt to improperly narrow construction of “metal impurities” to avoid prior art. It thus presented independent grounds under a

narrower construction. The Petition does not “mak[e] arguments under a claim interpretation that it recognizes is incorrect” (POR, 21), because the Choi-Istratov combination invalidates the claims under the plain and ordinary meaning of “impurities” *and* under Maxeon’s proposed construction. Ex.2037-Holman-Tr., 120:15-121:10.

Maxeon’s assertion that “[i]t is too late for petitioner to introduce argument and evidence” regarding claim construction (POR, 20) is backward. This Reply does not seek—or need—to introduce new argument or evidence because the Petition invalidates the claims even under Maxeon’s construction. Therefore, Maxeon’s reliance on *Intelligent Bio-Systems, Inc. v. Illumina Cambridge Ltd.*, 821 F.3d 1359 (Fed. Cir. 2016), is inapposite. Nor has Hanwha’s position changed since the Petition: construction of “metal impurities” is unnecessary, and the plain and ordinary meaning is sufficient to resolve the issues raised in the Petition. Even if this was a new argument—it is not—Maxeon cannot identify an APA violation. Maxeon responded to the Petition’s arguments regarding the “metal impurities” limitation based on both Choi alone and Choi combined with Istratov (and will have another opportunity in its Sur-Reply). *See ParkerVision, Inc. v. Vidal*, 88 F.4th 969, 980 (Fed. Cir. 2023).

Maxeon’s case citations are inapposite. In *Microchip Technology, Inc. v.*

Aptiv Technologies AG, the petitioner requested a construction consistent with the patentee's "implied construction" in co-pending litigation "if the district court adopts" that construction, which it did not. IPR2024-00494, Paper 12, 8-9 (P.T.A.B. Oct. 7, 2024). In *Vicor Corp. v. Delta Electronics, Inc.*, the Board denied institution because one ground was based on the patentee's "apparent construction" from a parallel proceeding, which the petitioner contended was not the "proper" construction, and the petitioner did not otherwise apply the *Phillips* standard. IPR2024-00704, Paper 11, 79 (P.T.A.B. Oct. 2, 2024). Here, the Petition clearly states that no construction is necessary (*i.e.*, that the correct construction is plain and ordinary meaning under *Phillips*), (Pet., 24); institution was not contingent on adoption of any construction; and the grounds were not based on an "improper" construction.

B. Choi-Istratov Render Obvious Emitter Regions Having "Metal Impurities"

Additionally, a POSITA would have been motivated to combine Istratov with Choi with a reasonable expectation of success.

1. Silicon Solar Cells Had Metal Impurities That Needed To Be Gettered

Maxeon does not dispute that gettering was common in 2014 for addressing metal impurities and improving solar cell performance. Ex.1090-Schubert-Tr., 118:17-119:12, 119:21-120:3; Ex.1091-Carroll-CSI-Decl., ¶38; Ex.1092-Carroll-

CSI-Tr., 71:8-10; *see also* Ex.1003-Decl., ¶¶84-89. Nor does it dispute that metal impurities were a pressing industry concern. Ex.2028-Schubert-Decl., ¶57; Ex.1090-Schubert-Tr., 118:10-16. Petitioner and Dr. Holman explain the specific “detriment[s] the metal impurities would cause” “in the substrate” (Paper 17, 21): they were known to “contribut[e] to recombination,” “thereby reducing the solar cell’s efficiency.” Ex.1003-Decl., ¶¶93, 205; Pet., 18, 45; Ex.1089-Reply-Decl., ¶¶44, 53-54. Maxeon contends there was no mention of any “problem of metal contaminants in Choi’s substrate” (POR, 23), but that is no surprise given the problem was well-known. As Dr. Carroll admits, “[i]n 2014,” the solar industry “used [] lower-quality silicon” substrates with “typical” “overall” metal “impurity concentration” “greater than” 10^{15} cm^{-3} . Ex.1092-Carroll-CSI-Tr., 25:2-26:18, 28:18-29:18. Typical monocrystalline silicon wafers contained transition metals at concentrations that resulted in reduced solar cell efficiency. Ex.1120-Coletti-2011, 6 (Table 1.1); Ex.1089-Reply-Decl., ¶¶44-62.

Iron was particularly prevalent and described as a “lifetime killer[]” due to its effects on carrier lifetime (Ex.1119-Coletti-2012, 94-96)—which is why Istratov evaluated gettering for iron. Ex.1012-Istratov, 568. Iron contamination was about “ $2.5 \times 10^{13} \text{ cm}^{-3}$ ” for typical solar-grade silicon wafers and around 10^{13} - 10^{14} cm^{-3} for solar-grade monocrystalline silicon in particular. Ex.1047-Istratov-2000, 492;

Ex.1139-Shabani, 183 (Table 2); Ex.1089-Reply-Decl., ¶¶52-57.

Maxeon fails to consider the second major source of metal impurities: subsequent device fabrication on the wafer. Ex.1003-Decl., ¶83. Metal impurities could be introduced from dozens of sources on the production line, and iron was known to be particularly “difficult to eliminate.” Ex.1047-Istratov-2000, 489, 491; Ex.1089-Reply-Decl., ¶¶46-47, 58-62.

For those reasons, gettering during solar cell fabrication was “necessary,” as Dr. Carroll admits. Ex.1092-Carroll-CSI-Tr., 25:2-27:4. Maxeon reads Dr. Holman’s testimony out of context to assert that gettering was unnecessary for some wafers. POR, 23. Because typical solar silicon wafers contained high levels of impurities, gettering was “a prerequisite for the production of efficient solar cells” as of 2014. Ex.1095-Seibt, 696; Ex.1089-Reply-Decl., ¶¶63-69.

Petitioner’s obviousness analysis is not “premised on” “knowledge of the ’315 patent itself” (Paper 17, 21), but rather on “the background knowledge possessed by” a POSITA, *KSR Int’l Co. v. Teleflex Inc.*, 550 U.S. 398, 405 (2007), which included knowledge about the presence of metal impurities and their effects on performance. The motivation to combine need not “be expressly lifted from” the references sought to be combined, but may be found in the “common knowledge” of a POSITA and “the nature of the problem itself.” *United Therapeutics Corp. v.*

Liquidia Techs., Inc., 2024 WL 3199314, *5 n.4 (Fed. Cir. June 27, 2024); *DyStar Textilfarben GmbH & Co. Deutschland KG v. C.H. Patrick Co.*, 464 F.3d 1356, 1361 (Fed. Cir. 2006). “[T]his is especially true where,” as here, “the motivation is to enhance commercial viability of a process” such as solar cell fabrication. *United Therapeutics*, 2024 WL 3199314, at *5 n.4.

2. Istratov Is Analogous Art

Maxeon’s assertion that “Istratov is not analogous art” is wrong for three reasons.

First, Istratov is both “pertinent to the particular problem” and in the “same field” as the ’315 patent. *In re Clay*, 966 F.2d 656, 659 (Fed. Cir. 1992). Like the ’315 patent, Ex.1001-USP315, 1:35-39, 4:65-5:25, Istratov is directed to improving device efficiency by reducing recombination caused by metal impurities through gettering. Ex.1001-USP315, 1:35-39, 4:65-5:25; Ex.1012-Istratov, 569; Ex.1090-Schubert-Tr., 137:8-11. They are in the same field because integrated circuits and silicon-based solar cells are closely related in structure and processing techniques. Ex.1003-Decl., ¶203; Ex.1090-Schubert-Tr., 49:18-50:5, 52:2-53:1. Dr. Schubert admits “silicon integrated circuits” and “solar cell devices” are not “separate fields” and the “solar field is a subfield of the semiconductor field[.]” Ex.1090-Schubert-Tr., 52:2-53:1; Ex.1089-Reply-Decl., ¶¶20, 70-72.

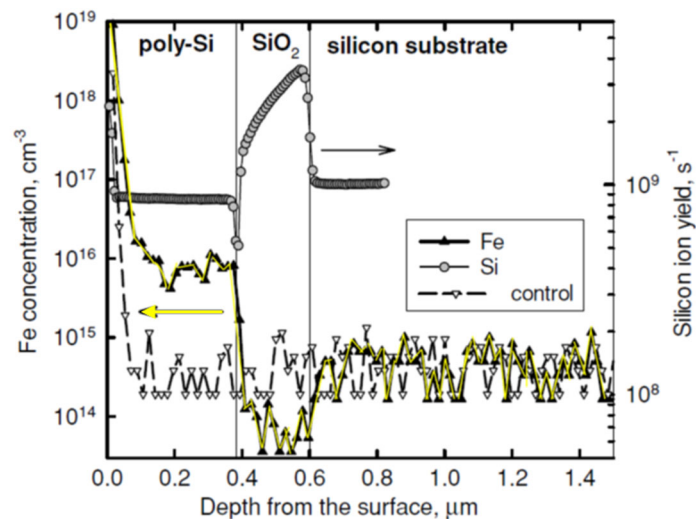
Second, Maxeon commits legal error by defining the problem to which Istratov was directed too narrowly. *See Donner Tech., LLC v. Pro Stage Gear, LLC*, 979 F.3d 1353, 1360 (Fed. Cir. 2020); *Cross Med. Prods., Inc. v. Medtronic Sofamor Danek, Inc.*, 424 F.3d 1293, 1323 (Fed. Cir. 2006) (POSITA “need not see the **identical** problem addressed in a prior art reference to be motivated to apply its teachings”).⁵ Maxeon attempts to narrowly define “the problem” faced by the inventors as “not being able to getter” “contaminants [**from** the] silicon substrate [**into** the] emitter regions,” and then misrepresents Istratov as gettering in the opposite direction by “mov[ing] impurities **from** [the] polysilicon device layer...[**into** the] substrate” (POR, 4-5, 25), as further explained below.

Third, Maxeon's description of Istratov makes several factual errors. Maxeon's reading relies on Istratov's “Introduction” of background research rather than Istratov's experiments and simulations. POR, 25 (citing Ex.1012-Istratov, 568); Ex.1090-Schubert-Tr., 133:4-14, 137:12-138:3; Ex.2037-Holman-Tr., 82:7-84:1.⁶ Like the '315 patent, Istratov's experiments evaluated the gettering of metal

⁵ Emphases are added unless otherwise indicated.

⁶ Maxeon misrepresents Dr. Holman's testimony, who did not “overlook[] Istratov's purpose” or fail to consider “Istratov's [I]ntroduction.” POR, 25. Dr. Holman “did

impurities *from* the substrate through the oxide layer and *into* the polysilicon layer. For example, Istratov introduced “[i]ron contamination” into the silicon substrate, as Dr. Schubert admitted. Ex.1012-Istratov, 570; Ex.1090-Schubert-Tr., 138:20-139:19, 140:17-141:5. Iron was gettered from the substrate through the oxide layer and into the polysilicon layer, as Istratov’s Figure 2 shows and Dr. Schubert confirmed. Ex.1012-Istratov, 570 (Fig.2); Ex.1090-Schubert-Tr., 139:20-140:16, 142:8-143:1.



Ex.1012-Istratov, 570, Fig.2 (annotated); Ex.1089-Reply-Decl., ¶¶73-77.

consider” Istratov’s Introduction, and testified it described “previous work in the state of the field” rather than Istratov’s work. Ex.2037-Holman-Tr., 82:7-84:1.

3. Choi and Istratov Are Not “Fundamentally Different,” Nor Would Istratov’s Gettering Process Be Detrimental to Choi

Maxeon’s arguments that Istratov is inapplicable to Choi due to differences in their oxide layer thicknesses and insulating versus tunneling qualities are a strawman. POR, 26-27. Despite those differences, metal impurities were successfully gettered through Istratov’s oxide layer, as Dr. Schubert admits. *Supra* p. 15. Istratov’s gettering through its thicker oxide layer demonstrates the same would be achieved in Choi’s significantly thinner oxide layer, which has a lower diffusion barrier. Ex.1090-Schubert-Tr., 146:16-147:3; Ex.1089-Reply-Decl., ¶78.

Maxeon’s arguments regarding purported “detrimental” impacts of incorporating Istratov’s gettering process into Choi’s solar cell (POR, 28) are based on speculation and improper bodily incorporation, which the Federal Circuit repeatedly cautioned against. *See, e.g., MCM Portfolio LLC v. Hewlett-Packard Co.*, 812 F.3d 1284, 1294 (Fed. Cir. 2015). Maxeon and Dr. Schubert cite no evidence and specify no particular processing temperature or time that could cause Choi’s tunnel oxide layer to “potentially dissolve,” dopants “to disperse throughout the silicon substrate,” or “impurities originally in Choi’s first and second conductive regions” to migrate into Choi’s substrate. POR, 28; Ex.2028-Schubert-Decl., ¶69. Gettering was routinely used in solar cell fabrication as of 2014 (*supra* pp. 10, 12), and determining an appropriate processing temperature and time was within the level

of ordinary skill. Given Choi's thinner oxide layer, a POSITA would have adapted Istratov's gettering process for Choi's solar cell structure by lowering the temperature and/or processing time to avoid any detrimental impacts. Ex.1089-Reply-Decl., ¶¶79-82.

C. Choi-Granek Or Choi-Marvin Render Obvious the Claimed Front Dopant Concentration

Maxeon does not contest that Marvin and Granek disclose the claimed front “dopant concentration of approximately less than or equal to $2 \times 10^{18} \text{ cm}^{-3}$,” that Marvin and Granek are analogous art, or that implementing the claimed dopant concentration in Choi would have been within a POSITA's capabilities. Nor does Maxeon argue that either Marvin or Granek teaches away from the claimed dopant concentration. Maxeon also fails to address the numerous other prior art references showing the claimed dopant concentration was widely disclosed by 2014 as a suitable option. Ex.1003-Decl., ¶¶79-82; Ex.1089-Reply-Decl., ¶83.

Maxeon's argument that Marvin and Granek do not teach the claimed dopant concentration is preferred is incorrect both legally and factually. POR, 42. The “law does not require that a particular combination must be the preferred, or the most desirable, combination described in the prior art.” *In re Fulton*, 391 F.3d 1195, 1200 (Fed. Cir. 2004). And factually, Marvin and Granek teach the claimed dopant concentration is suitable for a front surface field (“FSF”) such as Choi's.

1. Maxeon Misreads Marvin

For beginning-of-life (“BOL”) and 1 sun conditions, Marvin teaches an FSF doping concentration of 1×10^{17} to 1×10^{18} cm^{-3} balances surface and Auger recombination. Ex.1008-Marvin, 15; Ex.1090-Schubert-Tr., 169:5-11. Petitioner relies on this disclosure from Marvin that is representative of terrestrial conditions, which Maxeon and Dr. Schubert agree Marvin teaches. *See* POR, 29; Ex.2028-Schubert-Decl., ¶73; Pet., 41-42; Ex.1003-Decl., ¶201; Ex.1089-Reply-Decl., ¶¶84-86.

First, Maxeon mischaracterizes Marvin’s disclosure of the 1×10^{17} to 1×10^{18} cm^{-3} doping concentration as “irrelevant” and “[f]or space applications” with “increased radiation,” “end-of-life [EOL] performance.” POR, 30. Marvin clearly states on p. 15, and Dr. Schubert agrees, that 1×10^{17} to 1×10^{18} cm^{-3} is for “BOL,” “1 sun” conditions. Ex.1008-Marvin, 15; Ex.1090-Schubert-Tr., 169:5-171:21. Dr. Schubert explained BOL refers to the solar cell “*before* [it] is subjected to...*cosmic radiation*,” and 1 sun means “regular sunlight.” Ex.1090-Schubert-Tr., 165:10-14, 167:3-5. Dr. Schubert’s assertion that Marvin’s teachings on p. 15 are for “high cosmic radiation applications” is contradicted by Marvin’s text and Dr. Schubert’s testimony. Ex.1090-Schubert-Tr., 170:17-171:21. Maxeon also points to a separate disclosure on Marvin’s p. 25—on which Petitioner did not rely—of a “graded”

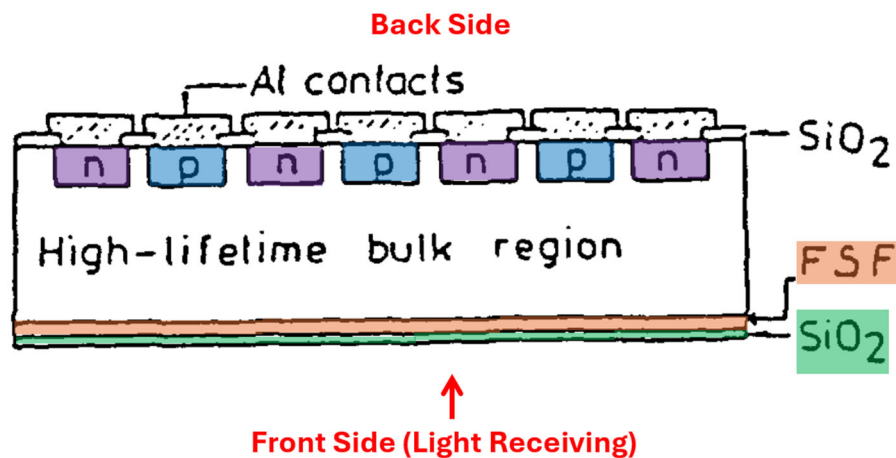
“FSF” doping concentration of 1×10^{17} to 1×10^{18} cm^{-3} for different conditions, *i.e.*, “a high radiation environment” “[to] maximize [EOL] performance.” POR, 30 (citing Ex.1008-Marvin, 25); Ex.2037-Holman-Tr., 34:19-36:3; Ex.1089-Reply-Decl., ¶¶87-88.

Second, Maxeon asserts a POSITA would have instead implemented Marvin’s FSF dopant concentration of 5×10^{18} cm^{-3} (POR, 29)—which is a separate disclosure Marvin teaches for space applications.⁷ That disclosure is from Marvin’s “Conclusion” for “[t]he design of IBC solar cells *for space use*” and “[n]ear optimal designs...*for missions*.” Ex.1008-Marvin, 25. Marvin’s Conclusion teaches 5×10^{18} cm^{-3} for “the low radiation environment” and “much more critical[ly] for 100 sun operation.” *Id.* Maxeon asserts the “low radiation environment” equates to “terrestrial application” (POR, 29), but that interpretation is proven wrong by the rest of the paragraph describing “space use” and “missions.” Ex.1008-Marvin, 25. Even Dr. Schubert agrees “low radiation does not necessarily mean terrestrial.”

⁷ Contrary to Maxeon’s mischaracterizations (POR, 30), Dr. Holman testified that he considered Marvin’s disclosure of 5×10^{18} cm^{-3} , but that it applied to “different” “conditions” than those “relied on in [his obviousness] combination.” Ex.2037-Holman-Tr., 32:10-34:2, 39:11-42:2.

Ex.2028-Schubert-Decl., ¶73. Marvin repeats elsewhere that $5 \times 10^{18} \text{ cm}^{-3}$ is for space applications, confirming it was not intended for terrestrial conditions. Marvin states: “**For space use**,...[t]he baseline cell parameters are near optimum for EOL efficiency.” Ex.1008-Marvin, 16. Dr. Schubert agrees the “baseline cell design” includes the “FSF doping” concentration of $5 \times 10^{18} \text{ cm}^{-3}$. Ex.1008-Marvin, 10; Ex.1090-Schubert-Tr., 159:7-21; Ex.1089-Reply-Decl., ¶¶89-90, 93-94.

Maxeon further asserts Marvin's disclosure of $5 \times 10^{18} \text{ cm}^{-3}$ is more relevant because Marvin optimized the carrier collection thicknesses for that FSF design. See POR, 30-31. As shown in Marvin's solar cell, the minority (n^+) and majority (p^+) carrier collection regions are on the back side, opposite from the FSF. Ex.1090-Schubert-Tr., 156:22-158:1.



Ex.1008-Marvin, 4 (Fig.1) (annotated). Varying the thicknesses of the carrier collections regions would not affect the FSF. See Ex.1124-Verlinden-2012, 332;

Ex.1089-Reply-Decl., ¶¶91-92.

Third, Maxeon attempts to discredit Marvin's findings as based on purportedly unreliable two-dimensional simulations and "not experimental results." POR, 31-32. Marvin is a reputable study, having used a modeling simulation program validated for accuracy. Ex.1008-Marvin, 7. Lower-dimensional simulations provide useful guidance when exploring design parameters, which Maxeon cannot dispute as it relied on two-dimensional simulation studies. *See* Ex.1090-Schubert-Tr., 218:18-21, 226:17-227:7; Ex.2003-Desa, 69, 71; Ex.2005-Procet, 128. Furthermore, numerous other studies find a similar optimal doping concentration. Ex.1003-Decl., ¶¶79-82; Ex.1089-Reply-Decl., ¶¶95-96.

Finally, Dr. Schubert's suggestion that Marvin's dopant concentration is not applicable to Choi's TOPCon solar cell relies again on improper bodily incorporation. Ex.2028-Schubert-Decl., ¶28; *supra* p. 16. Differences in Choi's and Marvin's rear regions would not have dissuaded a POSITA from implementing Marvin's FSF doping concentration in Choi's FSF region. *See* Ex.1124-Verlinden-2012, 332; Ex.1089-Reply-Decl., ¶¶97-98.

2. Maxeon's Arguments Regarding Granek Are Inapposite

Granek's experimental results do not teach a FSF dopant concentration greater than $2 \times 10^{18} \text{ cm}^{-3}$ is preferred. Maxeon ignores that Granek's simulation and

experimental results teach further lowering the dopant concentration below 3.8×10^{18} cm^{-3} would increase solar cell efficiency. Ex.1010-Granek, 121-122 (Figs.7-1, 7-3), 132 (Table 7-5); Ex.1089-Reply-Decl., ¶¶99-105.

Maxeon's assertion that Granek shows an FSF dopant concentration of 1×10^{19} cm^{-3} yields higher efficiency than 1×10^{18} cm^{-3} misinterprets Granek's Figure 7-1. POR, 34-37. Maxeon incorrectly assumes a POSITA would have focused on the portions of Figure 7-1 corresponding to front surface recombination velocities ("SRV") greater than 500 cm/s; however, Choi's (and Cousins') solar cells have well-passivated front surfaces with SRVs below 500 cm/s. Ex.1090-Schubert-Tr., 188:14-189:6; *see also* Ex.1118-Aberle-2000, 447; Ex.1041-Hermle, 1; Ex.1008-Marvin, 16-17. Maxeon ignores that Granek's Figure 3-6 shows a dopant concentration of 1×10^{18} cm^{-3} would result in an SRV of 100 cm/s. Ex.1010-Granek, 42 (Fig.3-6); Ex.1089-Reply-Decl., ¶¶106-111.

Maxeon's argument regarding Figure 7-1 with respect to solar cells without FSFs fails. POR, 37-38. Figure 7-1 shows that, at an extremely low front SRV of 1 cm/s, solar cells without FSFs can achieve efficiency comparable to those with FSFs. Maxeon, however, provides no evidence demonstrating the alleged "usefulness" of FSFs at such unusually low front SRV. Instead, a POSITA would have understood that adding an FSF would not increase the efficiency of solar cells with extremely

low SRVs. Ex.1089-Reply-Decl., ¶112.

Maxeon is wrong that achieving low SRVs would be a difficult endeavor. POR, 38-39. While King suggests that in 1990 SRV might have been “difficult to control,” by 2014 a POSITA would have understood how to achieve low SRVs. *See* Ex.1118-Aberle-2000, 447 (SRV of 10 cm/s in 2000); Ex.1041-Hermle, 1 (same in 2008); Ex.1089-Reply-Decl., ¶¶113-114.

Maxeon's objection to Petitioner's reliance on Figure 7-3 is unfounded. POR, 39-41. That figure's top graph does not apply to well-passivated front surfaces, like those of Choi and Cousins, but to front SRV of 1,000,000 cm/s. Ex.1010-Granek, 122 (Fig.7-3); Ex.2037-Holman-Tr., 67:1-68:3. A POSITA would have understood an SRV of 1,000,000 cm/s corresponds to solar cells with non-passivated front surfaces. Ex.1090-Schubert-Tr., 206:3-6. In contrast, Figure 7-3's bottom graph corresponds to “the case of passivated diffusion profiles.” Ex.1090-Schubert-Tr., 206:7-10. A POSITA would have focused on the bottom graph because Choi and Cousins have well-passivated front surfaces. Ex.1089-Reply-Decl., ¶¶115-117.

Maxeon's assertion that Granek's simulations have limited relevance is incorrect. POR, 41. Simulations are widely accepted and valuable tools in the solar field. A POSITA considering both Granek's simulation and experimental results would reasonably conclude that reducing the dopant concentration from 3.8×10^{18}

cm^{-3} to approach the simulation result of $1 \times 10^{18} \text{ cm}^{-3}$ would result in improved efficiency because both results demonstrate a clear trend of increasing efficiency with decreasing dopant concentrations over the simulated and experimented ranges. Ex.1089-Reply-Decl., ¶¶118-120.

3. A POSITA Would Not Have Chosen A Higher Front Dopant Concentration Based On Lamers, Desa, And Procel

Maxeon's arguments that Lamers, Desa, and Procel teach "preferred" front dopant concentrations of 3×10^{18} , 1×10^{19} , and $3.47 \times 10^{18} \text{ cm}^{-3}$, respectively, are irrelevant. POR, 42-45. Even if Maxeon's references were better options (they are not), the law of obviousness only requires a particular combination be "a suitable option," *Intel Corp. v. Qualcomm Inc.*, 21 F.4th 784, 800 (Fed. Cir. 2021).

Lamers' FSF doping level of $3 \times 10^{18} \text{ cm}^{-3}$ is not applicable to Choi. Lamers's FSF had dual functions for "reduc[ing] the recombination...and improv[ing] lateral transport" and had a "deep" "FSF profile." Ex.2002-Lamers, 2. Lateral function is not a function of Choi's FSF; its function is only to reduce recombination. Ex.1006-Choi, [0029]. For conditions applicable to Choi, Lamers cites to Granek and instructs the use of "a lightly doped and shallow FSF." Ex.2002-Lamers, 2, 4; Ex.1090-Schubert-Tr., 111:12-15. Granek teaches that such an FSF corresponds to the "well[-]passivated surface[]" from its "Figure 7-3 bottom," which shows recombination is lowest with dopant concentrations of $\sim 1 \times 10^{18} \text{ cm}^{-3}$ or lower.

Ex.1010-Granek, 122-123; Ex.1003-Decl., ¶¶149, 187. Maxeon's reliance on the dopant concentration of $5 \times 10^{18} \text{ cm}^{-3}$ is misplaced because Granek states such FSF is "lightly doped...and *deeply* diffused," as opposed to shallow. Ex.1010-Granek, 46; Ex.1089-Reply-Decl., ¶¶121-130.

Desa's solar cell has a different structure than Choi's, irrespective of Desa's inconsistent reference to it as a FSF and "floating junction." Ex.2037-Holman-Tr., 149:6-12; POR, 44-45. Desa uses a floating junction (*i.e.*, its front surface has the opposite doping polarity of the rest of substrate), which Dr. Schubert admitted "is not directly related to a front surface field" (Ex.2003-Desa, 70, 80; Ex.1090-Schubert-Tr., 221:19-222:20), given that an FSF has the same doping polarity as the substrate. Ex.1089-Reply-Decl., ¶¶131-132.

With respect to Procel (Ex.2005), the same research group later selected a FSF doping concentration of $1 \times 10^{18} \text{ cm}^{-3}$. Ex.1040-Procel, 15; Ex.2037-Holman-Tr., 151:14-153:22. Maxeon attempts to discredit the later Procel publication by arguing its "aim" was to evaluate "the impact of different rear geometries on" performance. POR, 45; Ex.1040-Procel, 15. But the parameters of the rear region are independent from the FSF region, and they can be optimized separately. Ex.1124-Verlinden-2012, 332; Ex.1089-Reply-Decl., ¶¶133-136.

**D. It Would Have Been Obvious To Use A P-Type Dopant In Choi
With All Other Claim Limitations (Claims 13-14)**

Maxeon does not dispute the obviousness of claims 13-14 based on the Choi-Marvin combination, both of which disclose p-type doped FSFs, but instead wrongly argues that it would not have been obvious to implement Granek's dopant concentration with Choi's p-type FSF. POR, 46. Maxeon's argument ignores that Choi specifically discloses a p-type FSF (Ex.1006-Choi, [0025], [0029]), and implementing Granek's dopant concentration in Choi's p-type FSF would have been a straightforward design choice for a POSITA. While Maxeon points to Granek's disclosure of different SRVs for boron (p-type) and phosphorus (n-type) as having a "direct impact on device performance" (POR, 47), the relationship between dopant concentration, SRV, and emitter saturation current density for boron and phosphorus was well-understood by 1990. Further, the '315 patent presumes a POSITA could design for both n- and p-type FSFs; it discloses only a single dopant concentration without describing any adjustments to account for any particular dopant or dopant polarity. *See* Ex.1090-Schubert-Tr., 230:6-21 ("[O]ne skilled in the art would be able to practice the invention as it is described"); Ex.1089-Reply-Decl., ¶¶137-138, 141-143.

Further, while the basis of Granek's Figure 3-6 (on which Maxeon relies) assumed a high SRV for p-type surfaces, by 2014 low SRVs could be achieved with

both n- and p-type silicon. Thus, a POSITA would have recognized that Granek's findings for n-type FSFs, with lower SRVs, provide reliable guidance for p-type FSFs. Ex.1089-Reply-Decl., ¶¶143-144.

Finally, a POSITA would have been motivated to select a p-type FSF and substrate because p-type wafers were more common and cheaper than n-type wafers in 2014, which Maxeon and Dr. Schubert do not dispute. POR, 54; Ex.2028-Schubert-Decl., ¶118; Pet., 78; Ex.1003-Decl., ¶427. Maxeon points only to a statement in Granek, published in 2009, referring to a "shortage" of p-type silicon "in recent years." POR, 54. However, in 2008-2009, there was a shortage *because* demand for wafers exceeded supply. The shortage abated by 2009, and Dr. Schubert provides no support for his conclusory assertion that "there was a shortage of p-type silicon in 2014." Ex.2028-Schubert-Decl., ¶118; *see* 37 C.F.R. § 42.65(a); Ex.1089-Reply-Decl., ¶¶139-140.

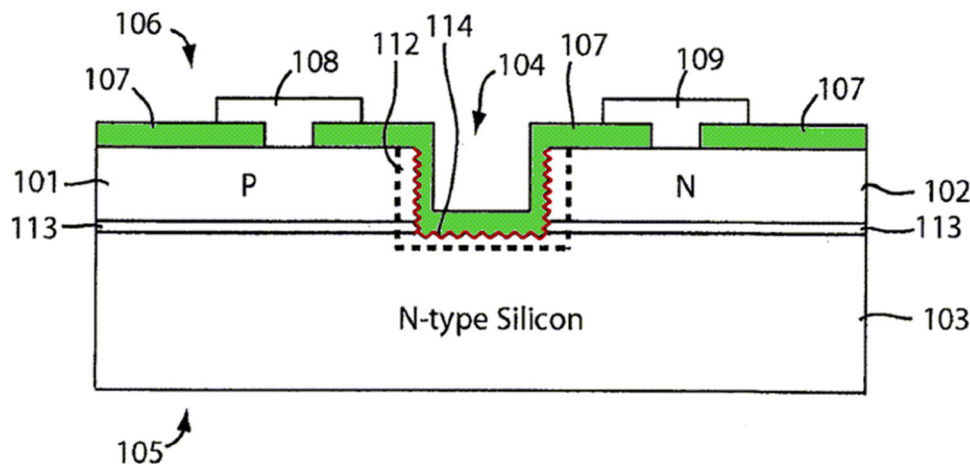
IV. CLAIM 18 IS OBVIOUS OVER CHOI, GRANEK OR MARVIN, AND OPTIONALLY ISTRATOV, IN VIEW OF SMITH (GROUND II)

Maxeon's POR does not individually challenge Petitioner's arguments concerning claim 18, and thus concedes Ground II rises and falls with Ground I. POR, 49. Claims 10 and 16 are unpatentable for the reasons explained above.

A motivation to combine may be found where the "references address precisely the same problem," a POSITA "would consult the references and apply

their teachings together.” *Ruiz v. A.B. Chance Co.*, 357 F.3d 1270, 1276-77 (Fed. Cir. 2004). Both Choi and Smith solve the same problems of improving surface passivation and preventing recombination. Ex.1006-Choi, [0029]-[0031]; Ex.1011-Smith, Abstract, [0022], [0025]; Ex.1089-Reply-Decl., ¶¶145-151.

The Board questioned why modifying Choi with Smith's trench “would be an improvement on what Choi already provides.” Paper 17, 25. As shown in Smith's Figure 2, Smith's trench includes a “textured surface 114” that “improves solar radiation collection of light incident on the back of the solar cell.” Ex.1011-Smith, [0021], [0025].



Ex.1011-Smith, Fig.2 (annotated). Further, Smith's trench is covered by the dielectric silicon nitride layer 107, which “repels minority carriers” to improve surface passivation. Ex.1011-Smith, [0022], [0025]. A POSITA would have recognized the additional collection of solar radiation and ability to repel minority

carriers achieved with Smith's trench would improve solar cell efficiency compared to using Choi's barrier area. Ex.1003-Decl., ¶¶344-345; Ex.1089-Reply-Decl., ¶¶152-153.

V. CLAIMS 10-15 ARE OBVIOUS OVER COUSINS, GRANEK OR MARVIN, AND ISTRATOV (GROUND III)

Maxeon relies on the same arguments made in Ground I to dispute the obviousness of claims 10-15 in view of Cousins, Granek or Marvin, and Istratov. POR, 49-51. Maxeon's arguments fail for the reasons already discussed. *Supra* §§III.B-III.D; Ex.1089-Reply-Decl., ¶¶154, 157-158, 163.

Maxeon wrongly asserts "Cousins does not disclose that its substrate has metal impurities." POR, 50. Cousins discloses a solar cell processing step for "cleaning [] the substrate 101 to remove metal contamination" (Ex.1007-Cousins, 4:23-35)—which a POSITA would have understood refers to metal impurities present in the silicon wafers and introduced during solar cell manufacturing. Ex.1089-Reply-Decl., ¶155.

Maxeon incorrectly suggests "Cousins's substrate would *not* include high levels of impurities" because SunPower, the "assignee of Cousins," "could have used 'extraordinarily high lifetime silicon starting material.'" POR, 50 (quoting Ex.1084, 11). Maxeon's arguments are premised on *extraordinary* silicon substrates and thus legally irrelevant to the motivation to combine analysis, which considers a

POSITA's "common knowledge." *Spectrum Pharms., Inc. v. Sandoz Inc.*, 802 F.3d 1326, 1333 (Fed. Cir. 2015). Moreover, SunPower is the assignee of other patent publications disclosing high "contamination levels" in the silicon substrate. Ex.1101-Wong-496, Fig.4, [0001], [0021]; Ex.1089-Reply-Decl., ¶156.

Maxeon also argues Granek's "simulations of Figure 7-4" were "imprecis[e]." POR, 51-54. Since dopant profiles FSF1 through FSF4 follow an error function ("erfc"), a POSITA would not have compared the values reported for these profiles in Table 7-1 to the values corresponding to a Gaussian profile shown in Figure 7-4. Ex.1010-Granek, 125 (Fig.7-6), 126 (Table 7-1); Ex.2037-Holman-Tr., 139:18-140:2. Although FSF5 may be approximated by a Gaussian function, it does not strictly follow a Gaussian distribution. Ex.1010-Granek, 125 (Fig.7-6); Ex.2037-Holman-Tr., 138:2-139:17. As such, a POSITA would have expected the values of Figure 7-4 for FSF5 to deviate from the experimental results listed in Table 7-1. Ex.1089-Reply-Decl., ¶¶159-162.

VI. CONCLUSION

Claims 10-20 of the '315 patent are unpatentable and should be canceled.

Respectfully submitted,

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Counsel for Petitioner

Petitioner's Table of Exhibits

No.	Description
1001	U.S. Patent No. 11,251,315 B2 ("USP315")
1002	File History for U.S. Patent No. 11,251,315 B2 (App. No. 16/877,255) ("USP315FH")
1003	Declaration of Dr. Zachary Holman Regarding U.S. Patent No. 11,251,315 ("Decl.")
1004	Declaration of June Munford ("Munford-Decl.")
1005	Complaint for Patent Infringement, <i>Maxeon Solar Pte. Ltd. v. Hanwha Solutions Corp., et al.</i> , Civil Action No. 2:24-cv-262 (E.D. Tex. Apr. 19, 2024), ECF No. 1 ("Complaint")
1006	U.S. Patent App. Pub. No. 2014/0311567 ("Choi")
1007	U.S. Patent No. 8,207,444 ("Cousins")
1008	D.C. Marvin, S.L. Froedege, "Interdigitated Back Contact Solar Cell Analysis and Design Recommendations for Space Use," Space Systems Division Air Force Systems Command, Report 88D-TR-90-04 ("Marvin")
1009	RESERVED
1010	F. Granek, High-Efficiency Back Contact Back-Junction Silicon Solar Cells (2009) (Ph.D. Dissertation, Fraunhofer Institute for Solar Energy Systems ISE) ("Granek")
1011	U.S. Patent App. Pub. No. 2013/0240029 ("Smith")
1012	A.A. Istratov, H. Väinölä, W. Huber, E. R. Weber, "Gettering in silicon-on-insulator wafers: experimental studies and modelling," <i>Semicond. Sci. Technol.</i> 20: 568–575 (April 2005) ("Istratov")
1013	EP1732142A1 ("Froitzheim")
1014	JP07-106611 ("Okayasu") (Translation)
1015	Translation Declaration for Okayasu

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1016	N. G. Tarr, "A polysilicon emitter solar cell," IEEE Electron Device Letters, vol. 6, no. 12, pp. 655-658, Dec. 1985 ("Tarr")
1017	U.S. Patent No. 6,262,359 ("Meier")
1018	Zachary C. Holman, Electron Transport in Amorphous Silicon (May 2005) (Thesis Presented to The Division of Mathematics and Natural Sciences, Reed College) ("Holman-Thesis")
1019	P.J. Verlinden, R.A. Sinton, K. Wickham, R.A. Crane, and R.M. Swanson, "Backside-contact silicon solar cells with improved efficiency for the '96 world solar challenge," in Proceedings of the 14th European Photovoltaic Solar Energy Conference, Barcelona, Spain, 96-9 (1997) ("Verlinden")
1020	R.A. Sinton and R.M. Swanson, "Simplified backside-contact solar cells," IEEE Transactions on Electron Devices, 37 (2), 348-52, (1990) ("Sinton")
1021	R.R. King, R.A. Sinton, R.M. Swanson, "Studies of Diffused Phosphorous Emitters: Saturation Current, Surface Recombination Velocity, and Quantum Efficiency," IEEE Transactions On Electron Devices, Vol. 37, No. 2 (Feb. 1990) ("King")
1022	W.P. Mulligan, D.H. Rose, M.J. Cudzinovic, D.M. De Ceuster, K.R. McIntosh, D.D. Smith, and R.M. Swanson, Manufacture of solar cells with 21% efficiency, in Proceedings of the 19th European Photovoltaic Solar Energy Conference, Paris, France, 387-90 (2004) ("Mulligan")
1023	J. Nelson, The Physics of Solar Cells, Imperial College Press, Chapters 1, 3, 4, 7, 9, 10 (2003) ("Nelson")
1024	R. F. Pierret, Semiconductor Device Fundamentals, Addison-Wesley Publishing Company, Inc., Excerpts from Chapters 1-4 (1996) ("Pierret")
1025	S.J. Fonash, Solar Cell Device Physics, Elsevier, Excerpts from Chapter 2 (2d Ed. 2010) ("Fonash")

No.	Description
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1027	O. von Roos, B. Anspaugh, “The Front Surface Field Solar Cell, A New Concept,” Proceedings of the 13th IEEE PVSEC, pp. 1119-1120 (1978) (“von Roos”)
1028	E. van Kerschaver, G. Beaucarne, “Back-contact Solar Cells: A Review,” Prog. Photovolt: Res. Appl. 14:107-123 (2005) (“van Kerschaver”)
1029	U.S. Patent No. 8,222,516 B2 (“USP516”)
1030	U.S. Patent No. 4,234,352 (“Swanson-352”)
1031	J. Bultman, I. Cesar, B. Geerligs, Y. Komatsu, W. Sinke, “Methods of emitter formation for crystalline silicon solar cells,” Photovoltaics International 6, pp. 69-80 (2012) (“Bultman”)
1032	U.S. Patent No. 5,444,001 (“Tokuyama”)
1033	I. Perichaud, “Gettering of impurities in solar silicon,” Solar Energy Materials & Solar Cells 72:315–326 (2002) (“Perichaud”)
1034	Mark John Kerr, Surface, Emitter and Bulk Recombination in Silicon and Development of Silicon Nitride Passivated Solar Cells (2002) (Ph.D. Thesis, The Australian National University) (“Kerr”)
1035	U.S. Patent App. Pub. No. 2012/0006392 (“Gupta”)
1036	File History for US 9,520,507 B2 (App. No. 14/579,935) (“USPA935FH”)
1037	File History for US 9,899,542 B2 (App. No. 15/213,273) (“USPA273FH”)
1038	File History for US 10,170,642 B2 (App. No. 15/876,927) (“USPA927FH”)
1039	File History for US 10,658,525 B2 (App. No. 16/228,165) (“USPA165FH”)

No.	Description
1040	P. Procel, V. Maccaronio, F. Crupi, G. Cocorullo, M. Zanuccoli, “Analysis of the Impact of Rear Side Geometry on Performance of Back-Contact Back-Junction Solar Cells,” 2014 Fotonica AEIT Italian Conference on Photonics Technologies, Naples, Italy, 2014, pp. 1-4, IEEE (2014) (“Procel”)
1041	M. Hermle, F. Granek, O. Schultz, S. W. Glunz, “Analyzing the effects of front-surface fields on back-junction silicon solar cells using the charge-collection probability and the reciprocity theorem,” J. Appl. Phys. 103, 054507 (2008) (“Hermle”)
1042	J. E. Cotter, J. H. Guo, P. J. Cousins, M. D. Abbott, F. W. Chen, K. C. Fisher, “P-Type Versus n-Type Silicon Wafers: Prospects for High-Efficiency Commercial Silicon Solar Cells,” IEEE TRANSACTIONS ON ELECTRON DEVICES, VOL. 53, NO. 8, (Aug. 2006) (“Cotter”)
1043	S.W. Glunz, R. Preu, D. Biro, “Chapter 1.16: Crystalline Silicon Solar Cells – State-of-the-Art and Future Developments,” Comprehensive Renewable Energy, Elsevier (2012)
1044	P.J. Verlinden, R. M. Swanson, R. A. Crane, “7000 High-efficiency Cells for a Dream,” Progress In Photovoltaics Research and Applications, VOL 2. 143-152 (1994) (“Verlinden-1994”)
1045	U.S. Patent No. 4,665,277 (“Sah”)
1046	M. Green, “Silicon solar cells: evolution, high-efficiency design and efficiency enhancements,” Semiconductor Science & Technology 8 (1993) (“Green”)
1047	A.A. Istratov, H. Hieslmair, E.R. Weber, “Iron contamination in silicon technology,” Appl. Phys. A 70, 489–534 (2000) (“Istratov-2000”)
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1051	M.D. Lammert and R.J. Schwartz, “The interdigitated back contact solar cell: a silicon solar cell for use in concentrated sunlight,” IEEE Transactions on Electron Devices, ED-24 (4), 337-42, (1977) (“Lammert”)
1052	D. Lysáček, M. Lorenc, L. Válek, “Structure and gettering properties of polycrystalline silicon layers,” Proceedings of the 16th Joint Seminar Development of Materials Science in Research and Education, Czechoslovak Association for Crystal Growth, published by Czech and Slovak Crystallographic Association, Praha 2006 (ISBN 80-901748-7-6) p. 40-41 (“Lysacek”)
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1054	BP Solar Global Marketing, BP-MSX-120, 120-Watt Multicrystalline Photovolataic Module (“BP-MSX-120”)
1055 — 1056	RESERVED
1057	P. Stradins, A. Dameron, S. Essig, V. Lasalvia, B. Lee, Y. Liu, J. Luo, W. Nemeth, A. Norman, M. Page, “Passivated Tunneling Contacts to N-Type Wafer Silicon and Their Implementation into High Performance Solar Cells,” NREL Conference Paper (Dec. 2014) (“Stradins”)
1058	D. M. Chapin, C. S. Fuller, G. L. Pearson, “A New Silicon p-n Junction Photocell for Converting Solar Radiation into Electrical Power,” Journal of Applied Physics 25, 676 (1954) (“Chapin”)
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1064	A. A. Istratov, W. Huber, E. R. Weber, "Experimental evidence for the presence of segregation and relaxation gettering of iron in polycrystalline silicon layers on silicon," Appl. Phys. Lett. 85, 4472–4474 (2004) ("Istratov-2004")
1065	KR1020130044982 ("Choi-982") (Translation)
1066	Translation Declaration for Choi-982
1067	RESERVED
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1088	Declaration of Mark D. Selwyn in Support of Petitioner's Notice of Intent to Designate Mark D. Selwyn, a Provisionally Recognized PTAB Attorney, as Back-Up Counsel Pursuant to 37 C.F.R. § 42.10(c)
1089	Reply Declaration of Dr. Zachary Holman Regarding U.S. Patent No. 11,251,315 ("Reply-Decl.")
1090	Deposition Transcript of E. Fred Schubert, July 15, 2025, in <i>Hanwha Solutions Corp. v. Maxeon Solar Pte, Ltd.</i> , IPR2024-01198 ("Schubert-Tr.")
1091	Declaration of David L. Carroll, Ph.D., in Support of Patent Owner's Response, April 8, 2025, in <i>Canadian Solar, Inc. v. Maxeon Solar Pte, Ltd.</i> , IPR2024-01038 ("Carroll-CSI-Decl.")
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CERTIFICATE OF COMPLIANCE

I hereby certify that the foregoing, Petitioner's Reply contains 5,593 words as measured by the word processing software used to prepare the document, in compliance with 37 C.F.R. §42.24(d), excluding the parts of the Petition exempted from the word count by 37 C.F.R. §42.24(a)(1).

Date: August 14, 2025

By: /Nora Xu/
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CERTIFICATE OF SERVICE

I hereby certify that on August 14, 2025, I caused a true and correct copy of the following materials:

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