

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

CANADIAN SOLAR INC.,
Petitioner,

v.

MAXEON SOLAR PTE. LTD.,
Patent Owner.

IPR2024-01039
Patent 8,222,516 B2

Before JO-ANNE M. KOKOSKI, KRISTINA M. KALAN, and
AVELYN M. ROSS, *Administrative Patent Judges*.

KALAN, *Administrative Patent Judge*.

JUDGMENT
Final Written Decision
Determining Some Challenged Claims Unpatentable
35 U.S.C. § 318(a)

I. INTRODUCTION

We have jurisdiction to conduct this *inter partes* review under 35 U.S.C. § 6 and to issue this Final Written Decision pursuant to 35 U.S.C. § 318(a). For the reasons that follow, we determine that Canadian Solar Inc. (“Petitioner”) shows by a preponderance of the evidence that claims 9–11 of U.S. Patent No. 8,222,516 B2 (“Ex. 1001, “the ’516 patent”) are unpatentable, but does not show by a preponderance of the evidence that claim 12 is unpatentable.

A. Procedural Background

Petitioner filed a Petition to institute an *inter partes* review of claims 9–12 (the “challenged claims”) of the ’516 patent. Paper 2 (“Pet.”). Maxeon Solar Pte. Ltd. (“Patent Owner”) filed a Preliminary Response. Paper 9. Pursuant to 35 U.S.C. § 314(a), we instituted an *inter partes* review of claims 9–12 on the grounds advanced in the Petition. Paper 13 (“Institution Decision” or “Inst. Dec.”). After institution of trial, Patent Owner filed a Patent Owner Response (Paper 25, “PO Resp.”), Petitioner filed a Reply (Paper 32, “Pet. Reply”), and Patent Owner filed a Sur-reply (Paper 35, “PO Sur-reply”).

We held an oral hearing on October 15, 2025, and a transcript is included in the record. Paper 42 (“Tr.”).

B. Real Parties-in-Interest

Petitioner identifies itself and Canadian Solar (USA) Inc. as the real parties-in-interest. Pet. 2. Patent Owner identifies itself as the real party-in-interest. Paper 5 (Mandatory Notice), 2.

C. Related Matters

The parties indicate that the '516 patent is at issue in the following district court proceedings:

- *Maxeon Solar Pte. Ltd. v. Canadian Solar Inc.*, 2-24-cv-00210 (E.D. Tex.);
- *Maxeon Solar Pte. Ltd. v. Hanwha Energy Corp.*, 2-24-cv-00262 (E.D. Tex.); and
- *Maxeon Solar Pte. Ltd. v. REC Solar Holdings AS*, 2-24-cv-00260 (E.D. Tex.).

Pet. 2; Paper 5, 2. Patent Owner also indicates that the '516 patent is at issue in the following proceeding before the Board:

- *Hanwha Solutions Corp. v. Maxeon Solar Pte. Ltd.*, IPR2024-01203 (filed Aug. 8, 2024).

Paper 6, 2.

D. The '516 Patent

The '516 patent, titled “Front Contact Solar Cell with Formed Emitter,” issued on July 17, 2012. Ex. 1001, codes (45), (54). The '516 patent discloses “structures for a relatively efficient and cost-effective front contact solar cell and processes for manufacturing [the] same.” Ex. 1001, 1:40–42. The '516 patent explains that a solar cell includes P-type and N-type diffusion regions that form a junction, and metal contacts that allow an external circuit to be coupled to and powered by the solar cell. Ex. 1001, 1:22–29. In a backside solar cell, both the diffusion regions and the metal contacts coupled to them are on the backside of the solar cell. Ex. 1001, 1:26–28. In a front contact solar cell, at least one of the metal contacts is on the front side of the solar cell, which is the side that faces the sun to collect solar radiation. Ex. 1001, 1:32–34.

The '516 patent shows one embodiment of its solar cell in Figure 1, reproduced below.

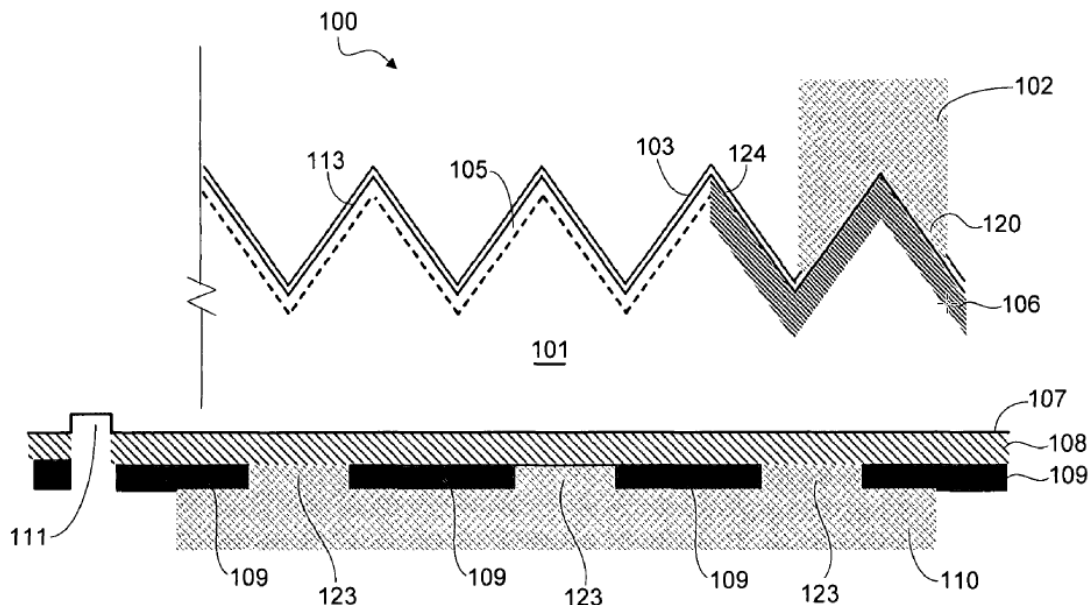


Figure 1 shows a cross-section of solar cell 100 with metal contact 102 on its front side, which faces the sun during normal operation, and metal contact 110 on its backside. Ex. 1001, 2:22–27. Solar cell 100 also includes N-type silicon substrate 101, tunnel oxide layer 107, polysilicon emitter 108, silicon dioxide layer 109, contact holes 123, and edge isolation trench 111. Ex. 1001, 2:28–31, 2:57–58, 2:66–3:2, 3:22–25. The front side of silicon substrate 101 is randomly textured (labeled as 113) and includes N-type doped regions 105 and 106, contact hole 120, and passivating oxide 124. Ex. 1001, 2:36–38, 2:53–56, 3:28–30.

E. Challenged Claims

Petitioner challenges claims 9–12 of the '516 patent. Claim 9 is the only independent claim challenged, and is reproduced below.

9. A solar cell having a front side facing the sun to collect solar radiation during normal operation and a backside opposite the front side, the solar cell comprising:
a substrate having a textured front surface;

- an emitter layer formed over a back surface of the substrate, the emitter layer forming a backside junction with the substrate;
- an oxide layer formed between the back surface of the substrate and the emitter layer;
- a first metal contact making an electrical connection to the substrate on the front side of the solar cell; and
- a second metal contact making an electrical connection to the emitter layer on the backside of the solar cell, the first metal contact and the second metal contact being configured to allow an external electrical circuit to be powered by the solar cell.

Ex. 1001, 6:42–57.

F. Asserted Grounds

Petitioner asserts that claims 9–12 would have been unpatentable on the following grounds:

Claim(s) Challenged	35 U.S.C. §	Reference(s)/Basis
9–11	103	Meier, ¹ Okayasu, ² Borden, ³ Jordan ⁴
9–11	103	Meier, Okayasu, Gan, ⁵ Foglietti, ⁶ Jordan,
9–12	103	Froitzheim, ⁷ Gan

¹ US 6,262,359 B1, issued July 17, 2001 (Ex. 1011).

² JP H7-106611, published April 21, 1995 (Ex. 1012 (English Translation); Ex. 1013 (Japanese Original)).

³ WO 2009/094578 A2, published July 30, 2009 (Ex. 1009).

⁴ US 2005/0268963 A1, published Dec. 8, 2005 (Ex. 1015).

⁵ J.Y. Gan et al., *Polysilicon Emitters for Silicon Concentrator Solar Cells*, The Conference Record of the Twenty First IEEE Photovoltaic Specialists Conference–1990, Vol. 1, pp. 245–250 (Ex. 1007).

⁶ US 2002/0142500 A1, published Oct. 3, 2002 (Ex. 1014).

⁷ EP 1732142 A1, published Dec. 13, 2006 (Ex. 1006).

Claim(s) Challenged	35 U.S.C. §	Reference(s)/Basis
9–12	103	Froitzheim, Kwark ⁸
9–12	103	Froitzheim, Borden

Petitioner relies on the declaration testimony of Dr. Sanjay Banerjee (Ex. 1003; Ex. 1067) in support of its contentions. Patent Owner relies on the declaration testimony of Douglas Ruby, Ph.D. (Ex. 2020).

II. ANALYSIS

A. Principles of Law

In an *inter partes* review, “the petitioner has the burden from the onset to show with particularity why the patent it challenges is unpatentable.” *Harmonic Inc. v. Avid Tech., Inc.*, 815 F.3d 1356, 1363 (Fed. Cir. 2016) (citing 35 U.S.C. § 312(a)(3) (2012) (requiring *inter partes* review petitions to identify “with particularity . . . the evidence that supports the grounds for the challenge to each claim”)). This burden of persuasion never shifts to the patent owner. *See Dynamic Drinkware, LLC v. Nat’l Graphics, Inc.*, 800 F.3d 1375, 1378 (Fed. Cir. 2015) (discussing the burden of proof in *inter partes* review).

Obviousness is a question of law based on underlying determinations of fact. *Graham v. John Deere Co.*, 383 U.S. 1, 17 (1966); *Richardson-Vicks, Inc. v. Upjohn Co.*, 122 F.3d 1476, 1479 (Fed. Cir. 1997). A claim is unpatentable as obvious, under 35 U.S.C. § 103, if the differences between the claimed subject matter and the prior art are such that the subject matter, as a whole, would have been obvious at the time of the invention to a person

⁸ Y.H. Kwark et al., *SIPOS Heterojunction Contacts to Silicon*, 1984 International Electron Devices Meeting TECHNICAL DIGEST, 1984, 742–745 (Ex. 1008).

having ordinary skill in the art. *KSR Int’l Co. v. Teleflex Inc.*, 550 U.S. 398, 406 (2007). The question of obviousness is resolved on the basis of underlying factual determinations including (1) the scope and content of the prior art; (2) any differences between the claimed subject matter and the prior art; (3) the level of ordinary skill in the art; and (4) objective evidence of nonobviousness.⁹ *Graham*, 383 U.S. at 17–18. Consideration of the *Graham* factors “helps inform the ultimate obviousness determination.” *Apple Inc. v. Samsung Elecs. Co.*, 839 F.3d 1034, 1048 (Fed. Cir. 2016) (en banc), *cert. denied*, 138 S. Ct. 420 (2017). Subsumed within the *Graham* factors are the requirements that all claim limitations be found in the prior art references and that the skilled artisan would have had a reasonable expectation of success in combining the prior art references to achieve the claimed invention. *Pfizer, Inc. v. Apotex, Inc.*, 480 F.3d 1348, 1361 (Fed. Cir. 2007). “Obviousness does not require absolute predictability of success . . . all that is required is a reasonable expectation of success.” *In re O’Farrell*, 853 F.2d 894, 903–04 (Fed. Cir. 1988) (citations omitted). But, a petitioner cannot satisfy its burden of proving obviousness by employing “mere conclusory statements.” *In re Magnum Oil Tools Int’l*, 829 F.3d 1364, 1380 (Fed. Cir. 2016).

We analyze the challenges presented in the Petition in accordance with the above-stated principles.

⁹ Petitioner asserts that the objective factors in the record support a conclusion of obviousness. Pet. 68–69. Patent Owner does not address objective indicia of nonobviousness. *See generally* PO Resp.; Tr. 21:15–16.

B. Level of Ordinary Skill in the Art

Petitioner contends that a person of ordinary skill in the art would have had “an advanced degree in electrical engineering, applied physics, chemistry, or materials science, and at least two years of experience designing, developing, or researching in the field,” or, alternatively, “a bachelor’s degree in electrical engineering, applied physics, or materials science, and at least three years of experience designing, developing, or researching in the field.” Pet. 3–4 (citing Ex. 1003 ¶ 45).

Patent Owner states that it applies the level of ordinary skill in the art that Petitioner proposes. PO Resp. 37 (citing Pet. 3–4).

In the Institution Decision, we adopted the assessment offered by Petitioner. Inst. Dec. 7–8. Because Petitioner’s definition of the level of skill in the art is consistent with the ’516 patent and the asserted prior art, we maintain it for purposes of this Final Written Decision. *See Okajima v. Bourdeau*, 261 F.3d 1350, 1355 (Fed. Cir. 2001).

C. Claim Construction

We construe each claim “in accordance with the ordinary and customary meaning of such claim as understood by one of ordinary skill in the art and the prosecution history pertaining to the patent.” 37 C.F.R. § 42.100(b). Under this standard, claim terms are generally given their plain and ordinary meaning as would have been understood by a person of ordinary skill in the art at the time of the invention and in the context of the entire patent disclosure. *Phillips v. AWH Corp.*, 415 F.3d 1303, 1313 (Fed. Cir. 2005) (en banc). Only those terms in controversy need to be construed, and only to the extent necessary to resolve the controversy. *Realtime Data, LLC v. Iancu*, 912 F.3d 1368, 1375 (Fed. Cir. 2019).

Based on our review of the complete trial record and the arguments raised by the parties, we determine that it is not necessary to expressly construe any claim terms to resolve the parties' dispute. *Realtime Data*, 912 F.3d at 1375.

D. Asserted Obviousness over Froitzheim and Gan

Petitioner contends that claims 9–12 would have been unpatentable as obvious in view of Froitzheim and Gan. Pet. 39–57.

1. Overview of Froitzheim

Froitzheim is directed to solar cells and a method of manufacturing solar cells that addresses light induced degradation of boron-doped base layers in solar cells. Ex. 1006 ¶¶ 1, 3. Froitzheim discloses a solar cell comprising an Si body layer of n-type bulk doping having a front side and a rear side, a non-alloyed p-type doped region at the rear side of the body layer and forming a p/n-junction with the rear side, a rear side contact in electrical connection with the p-type doped region, and a front side contact in electrical connection with the n-type silicon body layer. Ex. 1006 ¶ 10. According to Froitzheim, “the use of n-type Si as [the] body layer overcomes the degradation problem of conventional solar cells with a boron doped body layer.” Ex. 1006 ¶ 13. Froitzheim also teaches that “etching can be used to texture the surface in order to improve the geometry of incidence of light in order to prevent reflection.” Ex. 1006 ¶ 39.

2. Overview of Gan

Gan is directed to a study of polysilicon emitters with a thermally grown interfacial oxide layer. Ex. 1007, 245. Gan explains that the oxide is not thermally stable, and “tends to break up during high temperature anneals,” which has a “direct impact on both majority and minority carrier

transport in the polysilicon emitter.” Ex. 1007, 245. Gan was interested in the performance of polysilicon emitters “when only a small fraction of the interfacial oxide is broken,” and determined that “the cell performance can be improved” under certain circumstances. Ex. 1007, 245. Gan concluded that polysilicon emitters with improved performance “can be obtained with a very small fraction of interfacial oxide breakup,” and that “polysilicon emitters with these qualities can be quite useful for silicon concentrator solar cells.” Ex. 1007, 249.

3. *Analysis*

Petitioner contends that Froitzheim and Gan teach or suggest each limitation in Claim 9. Claim 9 recites “[a] solar cell having a front side facing the sun to collect solar radiation during normal operation and a backside opposite the front side.” Ex. 1001, 6:42–44. Petitioner contends Froitzheim discloses this limitation based on Froitzheim’s statement that “[d]uring normal operation of the solar cell 1, the front side 6 faces the sun and light is received through the area of the front surface that is not covered by the front contact 16.” Pet. 48 (quoting Ex. 1006, Fig. 1, ¶ 32).

Claim 9 next recites “a substrate having a textured front surface.” Ex. 1001, 6:45. Petitioner contends Froitzheim discloses this limitation based on Froitzheim’s statement that “[i]f desired[,] a short, alkaline crystal-oriented etching can be used to texture the surface in order to improve the geometry of incidence of light in order to prevent reflection.” Pet. 48–49 (quoting Ex. 1006 ¶ 39).

The next limitations in claim 9 are “an emitter layer formed over a back surface of the substrate, the emitter layer forming a backside junction with the substrate” and “an oxide layer formed between the back surface of

the substrate and the emitter layer.” Ex. 1001, 6:46–50. According to Petitioner, “the p-type doped emitter 10 [in Froitzheim] forms a ‘PN junction 12’ with the n-type substrate on the backside of the solar cell, and thus forms a ‘*backside junction*.’” Pet. 49 (citing Ex. 1006 ¶¶ 24–27). Petitioner further contends that a person of ordinary skill in the art, based on the teachings of Gan, would have replaced Froitzheim’s p-type diffused emitter with a p-type polysilicon emitter and oxide layer. Pet. 49–51 (citing Ex. 1007, 245).

Petitioner asserts that Froitzheim discloses “a first metal contact making an electrical connection to the substrate on the front side of the solar cell” and “a second metal contact making an electrical connection to the emitter layer on the backside of the solar cell,” as claim 9 requires. Ex. 1001, 6:51–54. For these limitations, Petitioner directs us to front side contacts 16 and rear side contact 15 in Froitzheim. Pet. 51–52 (citing Ex. 1006 ¶¶ 27–28).

Claim 9 also requires “the first metal contact and the second metal contact being configured to allow an external electrical circuit to be powered by the solar cell.” Ex. 1001, 6:54–57. Petitioner contends Froitzheim’s solar cell is configured to power an external circuit based on Froitzheim’s statement that “[f]ront and rear side contacts are arranged . . . in electrical connection with the n-doped layer and the p-doped base layer, respectively, to withdraw a photocurrent from both sides of the p/n-junction.” Pet. 53 (quoting Ex. 1006 ¶ 2). Petitioner contends that it was well-known that the purpose of withdrawing electric current from a solar cell is to power an external circuit. Pet. 53.

Petitioner also contends that Froitzheim and Gan are analogous art, and that a person of ordinary skill in the art would have had reason to replace Froitzheim's diffused emitter with a polysilicon emitter and oxide layer in view of Gan based on Gan's disclosure that "cell performance can be improved if the diffused-emitter is replaced with the polysilicon emitter." Pet. 42–43 (quoting Ex. 1007, 245) (emphasis omitted). Petitioner also directs us to Gan's statement that certain benefits in performance "may have to do with the use of thermal oxide as the interfacial layer" in its samples. Pet. 43 (quoting Ex. 1007, 248).

Petitioner also contends that a person of ordinary skill in the art would have had a reasonable expectation of success in achieving the claimed invention based on the combination of Froitzheim and Gan. According to Petitioner, a person of ordinary skill in the art

would have considered the Froitzheim/Gan combination to be merely an arrangement of old elements with each performing the same function it had been known to perform (the emitter of Froitzheim continuing to act as an emitter, but modified to be polysilicon with an interfacial oxide) and yielding no more than what one would expect from such an arrangement (a solar cell with improved performance).

Specifically, before introducing the boron dopant by diffusion at the rear side of the substrate (e.g., as described in Froitzheim's ¶¶40–41), the Skilled Artisan would perform Gan's steps of thin thermal oxide growth to form the interfacial layer and polysilicon deposition to form the polysilicon on the back side of the wafer, after which the polysilicon would be doped instead of the substrate to form the polysilicon emitter.

Pet. 47 (citing Ex. 1003 ¶¶ 152–153; Ex. 1007, 246).

Petitioner directs us to evidence in Gan and testimony from Dr. Banerjee that suggests Gan provided information regarding how to form

an oxide layer and doped polysilicon layer on a silicon substrate. Pet. 47–48; Ex. 1003 ¶¶ 152–155; Ex. 1007, 246–247.

Claim 12 depends from claim 9 and further provides: “wherein the second metal contact comprises silver formed over a layer of silicon dioxide.” Ex. 1001, 6:63–65. Petitioner argues that Froitzheim discloses this element, because (1) Froitzheim discloses that its rear contacts (*second metal contact*) are metal contacts that comprise silver and aluminum; (2) Figure 3 of Froitzheim discloses an alternative embodiment of the back contacts 35 where only a portion of the back is screen-printed; and (3) the second metal contacts (35) are also formed over a silicon dioxide layer (34) in Froitzheim because it disclosed that the rear contacts may be formed *after* a passivation layer of silicon dioxide is deposited. Pet. 55–57.

At oral hearing, Patent Owner explained its position as “we agree that the proposed combinations meet all of the elements except for Claim 12 of the ’516 patent.” Tr. 21:8–9; *see generally* PO Resp. Instead, focusing on motivation to combine, Patent Owner responds that claims 9–12 would not have been obvious based on Froitzheim and Gan:

A POSITA would not have been motivated to combine Froitzheim and Gan because if Froitzheim’s anneal temperatures for dopant drive in were used with an emitter as taught by Gan to include an interfacial oxide and polysilicon layers the result would exhibit high resistivity and high recombination and precluded Gan’s purported benefit. A POSITA would also have been discouraged by the lack of predictable results in reliably growing Gan’s oxide layer. EX2020, ¶188. Lastly, the incompatibility in the temperatures taught in Froitzheim and Gan for annealing to drive in dopants would have been readily apparent to a POSITA.

PO Resp. 42. Patent Owner further argues that Froitzheim and Gan teach away from each other. *Id.* at 50.

Regarding claim 12, Patent Owner argues, first, that Petitioner's proposed combination "is based on an alternative embodiment of Froitzheim" that "includes an additional passivation layer 34 and rear contacts 35 in a finger structure." PO Resp. 52. Patent Owner argues, second, that the proposed combination does not include a "second metal contact" with "silver formed over a layer of silicon dioxide" because "Froitzheim in fact discloses and illustrates that its passivation layer 34 is arranged *between* the rear contact 35 fingers," but, in the '516 patent, "the rear metal contact is formed *over* a layer of silicon dioxide because there are metal holes ensuring electrical contact." *Id.* at 53–54.

Petitioner replies that a POSITA would reasonably expect success in applying Gan's teachings to Froitzheim. Pet. Reply 1. More particularly, Petitioner argues that Froitzheim's temperatures would work to reduce J_0 (recombination). *Id.* at 2–4. Petitioner also argues that Gan's resistivity would work for a one-sun solar cell. *Id.* at 4–6. A POSITA, according to Petitioner, could reliably perform oxide growth before 2008. *Id.* at 6–10. A POSITA also, according to Petitioner, would be motivated to combine Froitzheim and Gan to develop an improved solar cell. *Id.* at 10–11. Patent Owner's teaching away argument fails, argues Petitioner, because Froitzheim's identification of its annealing range "does not meet the high threshold required to establish teaching away." *Id.* at 12–14.

Regarding claim 12, Petitioner argues: "Unable to overcome Froitzheim's clear disclosure of a metal contact comprising silver formed over a layer of silicon dioxide," Patent Owner "resorts to construing claim

12 exceedingly narrowly” in a way that “amounts to defining the term ‘over’ to exclude formation of a metal contact on the silicon dioxide layer ‘after’ the passivation layer by reading in several limitations from the specification.” *Id.* at 14–15.

Patent Owner responds that Petitioner’s theory based on Froitzheim and Gan is unsound, because the record fails to support a diffusion time-temperature combination that is compatible with both Gan and Froitzheim. PO Sur-reply 1–4. According to Patent Owner, Petitioner has not demonstrated that Froitzheim’s diffusion temperature would work on Gan’s polysilicon emitter. *Id.* at 4–6. Petitioner, moreover, has “not identified a viable method to grow thin oxides in solar cells.” *Id.* at 6–10. Patent Owner also argues that a POSITA would have given equal consideration to the Gan Thesis and Gan. *Id.* at 10–13. Finally, Patent Owner argues that Petitioner has not established that increased resistivity would affect one sun cells less. *Id.* at 13–15.

Regarding claim 12, Patent Owner argues that Petitioner’s argument “misses the mark.” *Id.* at 15–17. More particularly, Patent Owner argues that the “issue is that forming after does not mean forming over,” and that “Petitioner has not pointed to any description in Froitzheim to suggest that its metal contacts are formed over the passivation layer.” *Id.* at 16.

a) Reasonable Expectation of Success

Patent Owner argues that the combination of Froitzheim and Gan (1) would have “exhibited high resistivity and high recombination,” (2) lacks “predictable results in reliably growing Gan’s oxide layer,” and (3) would have “incompatibility in the temperatures taught in Froitzheim and Gan for annealing to drive in dopants.” PO Resp. 42.

(1) annealing temperatures

Patent Owner argues that a person of ordinary skill in the art would have avoided the high temperature dopant drive-in described in Froitzheim because Gan prefers a lower dopant drive-in temperature. PO Resp. 43. Patent Owner explains that, according to Gan, “polysilicon emitters with $J_o \leq 5 \times 10^{-14}$ A/cm² and $\rho_c \sim 1 \times 10^{-5}$ Ω/cm² [are] ‘quite useful for silicon for silicon concentrator solar cells.’” *Id.* (citing Ex. 1007, 249). Patent Owner explains “Gan’s device undergoes two anneals: a first-step anneal at 1050°C following polysilicon deposition, and a second-step anneal at 900°C-1000°C to drive-in dopants.” *Id.* (citing Ex. 1007, 246). Further, Patent Owner asserts that “even at . . . 900°C, the resulting Froitzheim-Gan combination would yield a value of ρ_c that is higher than what Gan finds useful,” i.e., a ρ_c above 5×10^{-5} Ω/cm². PO Resp. 44–45. Patent Owner argues that at Froitzheim’s preferred temperatures of between 1000 and 1100 °C, the resulting J_o and ρ_c would be unacceptable. *Id.* at 45. As a result, Patent Owner contends a person of ordinary skill in the art would not have had a motivation to combine the teachings of Froitzheim and Gan. *Id.* at 46.

On this record, we are persuaded Petitioner has shown that a person of ordinary skill in the art would have had a reasonable expectation of success in combining the teachings of Froitzheim and Gan. Patent Owner’s arguments to the contrary do not convince us otherwise.

Petitioner explains that the combination of Froitzheim and Gan simply replaces one emitter for another, i.e., the diffused emitter of Froitzheim for the polysilicon emitter of Gan. Pet. 42. Gan explains that “the cell performance can be improved if the diffused-emitter is replaced with the polysilicon emitter.” Ex. 1007, 245. Dr. Banerjee testifies that “substituting

Froitzheim’s in-substrate emitter with a deposited polysilicon emitter and oxide layer would be simple substitution of one known element.” Ex. 1003 ¶ 154. Petitioner explains that in its combination, and before introducing the boron dopant by diffusion at the rear side of the substrate (for example, as described in ¶¶ 40–41 of Froitzheim), the skilled artisan “would perform Gan’s steps of thin thermal oxide growth to form the interfacial layer and polysilicon deposition to form the polysilicon on the back side of the wafer, after which the polysilicon would be doped instead of the substrate to form the polysilicon emitter. Pet. 47 (citing Ex. 1003 ¶ 153, Ex. 1007, 246). Petitioner, through the testimony of Dr. Banerjee, states that “[c]ombining Froitzheim/Gan as described here would have been well within the level of ordinary skill in the art” (Ex. 1003 ¶ 153) and would “have been the combination of prior art elements according to known methods to yield predictable results” (*id.* ¶ 154). Patent Owner does not allege that the proposed combination would have been outside the skill level of the ordinarily skilled artisan. *See generally* PO Resp.

Instead, Patent Owner alleges that subjecting Gan’s oxide layer to Froitzheim’s high temperature anneal would have resulted in high recombination, i.e., J_0 . PO Resp. 43. We do not find Patent Owner’s argument and evidence persuasive. Both Froitzheim and Gan describe dopant drive in temperatures ranging from 900–1200 °C and 900–1000 °C, respectively, showing an overlap at 900–1000 °C. Ex. 1006 ¶ 42; Ex. 1007, 246; *see also* Ex. 1066, 76:9–12 (Patent Owner’s declarant acknowledging that using an anneal temperature 900 °C as beneficially taught by Gan is within the range disclosed by Froitzheim). Gan explains that

the J_0 increases with the temperature and time of the second-step anneal. In the meantime, the ρ_c decreases as the drive-in temperature increases. Considering the significant increase of J_0 caused by increasing the drive-in temperature from 900 to 1000 °C, it is beneficial to use the two-step-anneal to optimize J_0 .

Ex. 1007, 248; *see also id.* (Table 1). Notably, Gan states only that the J_0 “significantly increase[s]” between 900 and 1000 °C—not where that increase occurs or that the increase, even a “significant” one, would be deemed unacceptable at 1000 °C. Moreover, Petitioner presents evidence that even at 1000 °C, there are improved results. Pet. Reply 2 (citing Ex. 1007, 248 (Table 1), 249) (stating that Patent Owner “ignores that even at higher temperatures of 1000 °C, the temperature [Patent Owner] argues Froitzheim prefer[s], Gan shows that J_0 under that condition was still lower than the J_0 for diffused emitters.”).

Patent Owner’s arguments rest on Froitzheim’s disclosure that anneal temperatures of 1000–1100 °C are preferred (PO Resp. 45–46; Tr. 24, 28, 29) and an understanding that Gan’s second anneal should be at or below 900 °C (PO Resp. 43–44; Tr. 28). Patent Owner’s arguments rest on two faulty assumptions. First, disclosures in the prior art not limited to the preferred embodiment, rather, “all disclosure[s] of the prior art, including unpreferred embodiments, must be considered,” including the lower temperature disclosed in Froitzheim, i.e., 900 °C. *See In re Lamberti*, 545 F.2d 747, 750 (CCPA 1976). Second, Patent Owner fails to direct our attention to any disclosure in Gan that suggests the second anneal should be at 900 °C *or below*. Indeed, each citation referenced by Patent Owner describes an anneal temperature of 900 °C and 1000 °C—*not* at or below 900 °C. PO Resp. 44; Ex. 1007, 246 (describing process sequence 10 as

“Drive-in: 900–1000 °C”), 248 (Table 1 illustrating the effect of the second annealing step at temperatures of 900° and 1000 °C), 249 (Figure 6 showing experimental results at 900° and 1000 °C). Nothing we are directed to in Gan states that below 900 °C is desired. *See generally* Ex. 1007.

Patent Owner also contends that an anneal temperature of 900 °C results in suboptimal ρ_c , or current density. PO Resp. 44. According to Patent Owner, “at 900 °C, Gan’s P-type polysilicon emitters have a ρ_c of 18 $\mu\Omega\text{-cm}^2$ (or $1.8 \times 10^{-5} \Omega/\text{cm}^2$), which is higher than the value of $\rho_c \sim 1 \times 10^{-5} \Omega/\text{cm}^2$ that Gan deems to be useful.” *Id.* (citing Ex. 1007, 248 (Table 1)).

But, Gan states that

[t]he data shown in Fig. 6 are ***quite useful*** for silicon solar cells. First, most of J_0 are ***below $5 \times 10^{-14} \text{ A/cm}^2$*** which is about one order magnitude lower than that of diffused-emitters. Second, most of ρ_c are ***also lower than $5 \times 10^{-5} \Omega/\text{cm}^2$*** . This means that the potential drop across the contact is negligible as long as the current density is less than 100 A/cm^2 .

Ex. 1007, 249 (emphasis added). Thus, at an anneal temperature of 900 °C, the J_0 and ρ_c reported by Gan are considered “useful.” *Compare* Ex. 1007, 248 (Table 1), *with id.*, 249.

Furthermore, and relying on the testimony of Dr. Banerjee, Petitioner aptly states that the “current density of the Fritzscheim-Gan combination is well below 100 A/cm^2 , as ‘100 A/cm^2 ’ is at the extreme ‘equivalent to 2500 suns’ corresponding to silicon concentrator solar cells, while the Fritzscheim-Gan combination generates a one-sun solar cell.” Pet. Reply 5 (citing Ex. 2020 ¶ 135 (Dr. Ruby confirming that “high current levels in the range of 100 A/cm^2 ” are “equivalent to 2500 suns”)). Dr. Banerjee testifies that “non-concentrator one sun solar cells do not generate that high of a current density because there is less light hitting the solar cell. Thus, for standard

operations, a one sun cell does not require as low of specific contact resistivity (ρ_c) as concentrator solar cells.” Ex. 1067 ¶ 26. Therefore, even if an anneal temperature of 900 °C results in suboptimal ρ_c as Patent Owner alleges, “non-concentrator cells do not suffer from having values of ρ_c that would otherwise render a concentrator cell not useful” and the person of ordinary skill in the art “would not have been discouraged from combining Froitzheim and Gan based on Gan’s disclosure of a ρ_c of $1.8 \times 10^{-5} \Omega\text{-cm}^2$.” Ex. 1067 ¶ 28. We find Dr. Banerjee’s testimony credible.

(2) *thin-oxide layer growth*

Patent Owner asserts that a “POSITA would also not have a reasonable expectation of success in combining the polysilicon and oxide layer emitter of Gan with the silicon wafer disclosed in Froitzheim,” and that a separate reference, the Gan Thesis,^[10,11] “explains that an object was to obtain a low J_o ” and both Gan and the Gan Thesis are “trying to solve the same problem, namely a very small and consistent breakup of the interfacial

¹⁰ Jon-Yiew Gan, Polysilicon Emitters for Silicon Concentrator Solar Cells (July 1990) (Ph.D. dissertation, Stanford University) (Ex. 2003, “the Gan Thesis”).

¹¹ In our Decision on Institution, we expressed some concern because the evidence of record did not support the public availability of the Gan Thesis. Inst. Dec. 14, 18 n.12. Over the course of trial, the Patent Owner provided some evidence suggesting the Gan Thesis was publicly available on or about April 10, 1991. *See, e.g.*, Ex. 2022 ¶¶ 18–23 (noting a MARC record creation date of April 10, 1991 and concluding that the Gan Thesis “could have been located by a skilled researcher” as of that date). Patent Owner’s evidence appears to address our initial concern. Because Petitioner does not object and because the outcome of this Final Written Decision does not depend on the resolution of this issue, for purposes of this Decision, we assume that the Gan Thesis would have been known to the skilled artisan at the time of invention.

oxide to achieve low J_o .” PO Resp. 46–47 (citing Ex. 2020 ¶ 203). Patent Owner alleges that the Gan Thesis describes its thin-oxide growth as unreliable, unpredictable, and difficult to reproduce. PO Resp. 47–49. Thus, Patent Owner reasons that a person of ordinary skill in the art “would read the Gan Thesis and determine[] that the experiments discussed in Gan produced unreliable results, created ‘mishap[s],’ produced reproducibility problems, and the good results were only theoretical.” *Id.* at 49 (citing Ex. 2020 ¶ 205).

Patent Owner’s arguments are based primarily on the Gan Thesis, which according to Patent Owner should be treated as “supplemental” to Gan. Tr. 27:3–8 (stating that “it’s the same work. It’s literally the same experiments, just in more detail. So we would ask that you consider it as a supplementary reference”). Patent Owner, however, does not direct our attention to any precedent that would require, or even permit, reading Gan together with the Gan Thesis as a unified work. *See generally* PO Resp. We reject Patent Owner’s invitation to treat the Gan Thesis as an extension of Gan. In our view, the Gan Thesis has value in that it reflects the contemporaneous state of the art, but the Gan Thesis does not supplant Gan’s teachings.

We acknowledge that the Gan Thesis, by way of example, states that:

[T]he breakup process is difficult to control. On several occasions, we have encountered reproducibility problems. [Ex. 2003, 107].

[S]olar cells that were made in this study all suffered high contact resistance. The problem is primarily due to insufficient oxide

breakup, and is caused by the fluctuation of the thickness of the interfacial oxide. [Ex. 2003, 107].

[W]e found that a consistent result of ρ_c is difficult to reproduce for the polysilicon emitter with a thermally grown interfacial oxide. [Ex. 2003, 116].

[O]ur thin-oxide growth recipe is not reliable. . . . In order to have predictable results, it appears that a precise control of the oxide thickness is necessary. [Ex. 2003, 117].

It appears that the oxide breakup depends critically on the interfacial oxide thickness. The thin-oxide growth recipe used in this work was not reliable. [Ex. 2003, 119].

It is then clear that a more reliable way of growing the thin oxide is needed. [Ex. 2003, 119].

However, these statements do not suggest, as Patent Owner asserts, that “Gan showed that there was no known method for getting the oxide thickness reliably to obtain his best results.” PO Resp. 47; *but see* Ex. 2003, 108 (stating that even though “the oxide-growth recipe is not reliable, it was ignored because the results are still good enough for emitters to be used in the concentrator solar cells.”).

Moreover, Gan itself suggests a level of success in interfacial oxide growth. For example, Gan states:

Polysilicon emitters with a thermally grown interfacial oxide are examined in great detail. [Ex. 1007, Abstr.].

In this paper, detailed calibrations for the polysilicon emitter with a thermally grown interfacial oxide is presented. Compared with

the [] chemical oxide, the thermal oxide appears to be more robust to the high temperature anneal. [Ex. 1007, 245].

The process sequence is shown as followings : . . . 3. Thin thermal oxide growth at 800 °C (10-minute oxygen flow). [Ex. 1007, 246].

The growth of thin oxide was carried out with 200 sccm oxygen and 5 slm argon mixture. Typically, oxide thickness less than 20 Å was measured with ellipsometer. [Ex. 1007, 246].

Gan does not complain about oxide growth or identify unreliable oxide growth as a barrier that precludes success. *See generally* Ex. 1007.

Furthermore, that there may be some level of unpredictability, as reflected in the Gan Thesis, does not defeat obviousness because “obviousness cannot be avoided simply by a showing of some degree of unpredictability in the art so long as there was a reasonable probability of success.” *Pfizer, Inc.*, 480 F.3d at 1364; *see also In re Longi*, 759 F.2d 887, 896 (Fed. Cir. 1985) (“Only a reasonable expectation of success, not absolute predictability, is necessary for a conclusion of obviousness.”).

In addition, “[w]hen prior art contains apparently conflicting references, the Board must weigh each reference for its power to suggest solutions to an artisan of ordinary skill” and, in so doing, “consider the degree to which one reference might accurately discredit another.” *In re Young*, 927 F.2d 588, 591 (Fed. Cir. 1991). The Gan Thesis describes known techniques that the skilled artisan could have employed to improve thin oxide growth. The Gan Thesis states that “it appears that the variation of the oxide thickness results mainly from the oxide-growth step. If this is the case, it is possible that the thin-oxide growth can be improved by performing the oxidation at a lower temperature such that the oxidation rate can be controlled more precisely.” Ex. 2003, 112. Though Patent Owner

characterizes this disclosure as “an unproven assumption” or “speculation at best” (Tr. 32:35–36), Drs. Banerjee and Ruby disagree. For example, Dr. Banerjee explains:

Lowering the temperature slows down the chemical reaction between silicon and oxygen in the formation of silicon oxide and thus allows for greater control on the thickness of the oxide layer. As Gan Thesis shows, the oxide thickness increases with time, and slowing that process down by lowering the temperature allows a Skilled Artisan to optimize the oxygen flow time in order to achieve the desired thickness.

Ex. 1067 ¶ 19 (citing Ex. 2003, 111). Dr. Banerjee further testifies that “since at least the 1990s,” the ordinarily skilled artisan was equipped with methods to reliably grow oxide layers with controlled thicknesses. Ex. 1067 ¶ 12. “These methods were able to finely tune conditions such as reaction time, temperature, pressure, and oxygen concentration of the oxidation reaction as it occurs to obtain reliable formation of thin oxide layers.” Ex. 1067 ¶ 12; *see id.* ¶ 19. Dr. Ruby, Patent Owner’s declarant, offers similar testimony explaining that prior to 2008, it was known that lowering the temperature at which the oxide is formed will slow the growth rate of that oxide. Ex. 1066, 103:3–18.

Accordingly, the evidence of record suggests that the skilled artisan, at the time of invention, would have had a reasonable expectation of success in the combination of Froitzheim and Gan.

b) Reason to Combine

Patent Owner asserts that because “there would have been no basis for a reasonable expectation of success in combining Froitzheim with Gan . . . a POSITA would not have been motivated to combine the references.” PO Resp. 49. Specifically, Patent Owner asserts that “because any advantages

in J_o and ρ_c proposed by Gan would be unattainable as a consequence of the temperature range, including the preferred temperature range, disclosed by Froitzheim” (*id.*), and “because the Gan Thesis, which discusses the work of the Gan reference in greater detail, tells the POSITA that the oxide layer required in the combination consistently fails, is unreliable, and at best remains a theoretical improvement” (*id.* at 49–50), a person of ordinary skill in the art would not have had reason to combine Gan and Froitzheim.

Patent Owner’s arguments above rely on a lack of reasonable expectation of success as the basis for its assertion that the ordinarily skilled artisan would not have had a reason to combine the teachings of Froitzheim and Gan in the manner suggested by Petitioner. PO Resp. 42–49. Because we rejected Patent Owner’s arguments based on reasonable expectation of success above, we similarly reject Patent Owner’s arguments here for the same reasons.

Patent Owner, however, additionally contends that because “[c]oncentrator cells generate multiple times more free electrons than one sun solar cells requiring concentrator solar cells to have a much lower resistive path from the substrate to the emitter, through the metal contacts and gridlines, than in a one sun solar cell,” a person of ordinary skill in the art would not have had reason modify the teachings of Froitzheim (one sun solar cell) with those of Gan (concentrator solar cell). PO Resp. 50.

We are convinced Petitioner has shown that a person of ordinary skill in the art would have had a reason to combine the subject matter of Froitzheim and Gan for the reasons expressed by Petitioner (Pet. 42–48) and discussed above (*see supra*). Patent Owner’s arguments in response are not persuasive.

Though Gan’s teachings are directed to silicon concentrator solar cells, the ordinarily skilled artisan would have understood Gan also refers to silicon solar cells in general. *Compare* Ex. 1007, 249 (stating “[t]he data in Fig. 6 are quite useful for *silicon solar cells*” and “cell efficiency is obtained for a *backside contact solar cell*”), *with id.* (explaining that “polysilicon emitters with these qualities can be quite useful for silicon *concentrator solar cells*”). Dr. Banerjee testifies that “the Skilled Artisan would interpret Gan as recommending the feature for solar cells in general” and “that its polysilicon emitter with interfacial oxide feature is beneficial for solar cell efficiency in general.” Ex. 1003 ¶ 146; Ex. 2023, 93:10–15. Furthermore, Dr. Ruby testified that when designing solar cells, he reviews published works in the field and would not necessarily limit his review to the type of solar cell being developed. Ex. 1066, 48:4–51:16.

Q So you would agree that if you're developing a 1-Sun solar cell, it might be worthwhile to look at publications regarding concentrator solar cells?

* * *

THE WITNESS: Well, it would be advisable or suggest -- you know, it would certainly be worth -- worth looking at, although not all of the methods for creating solar cells -- concentrator cells are required for producing 1-Sun cells. So some things would be of use and many things would not.

Ex. 1066, 51:7–16. That Dr. Banerjee and Dr. Ruby each testify that a person of ordinary skill in the art would have had reason to consult the teachings of both concentrator and non-concentrator solar cells—in fact describing such consideration as “advisable,” “suggest[ed],” and “worth looking at”—when designing a solar cell is dispositive of this issue. We acknowledge Dr. Ruby’s testimony that consideration of broader teachings

may hinge on a specific application for the solar cells. Ex. 1066, 51:7–16. But the combination proposed here by Petitioner, which substitutes one known emitter for another, that is, a polysilicon emitter for a diffused emitter, to improve efficiency of solar cell performance, has been shown to have general applicability regardless of solar cell type. Ex. 1003 ¶¶ 142–148 (citing Ex. 1006, Abstr., ¶¶ 1, 9; Ex. 1007, 245, 248, 249; Ex. 1014; Ex. 1039); Ex. 1067 ¶¶ 21–28; Ex. 2023, 32:2–11.

Accordingly, we are persuaded that Petitioner has shown that the ordinarily skilled artisan would have had a reason to combine the teachings of Froitzheim and Gan with a reasonable expectation of success. We determine Petitioner has demonstrated by a preponderance of the evidence that the combination of Froitzheim and Gan would have rendered claim 9 obvious.

c) Alleged Teaching Away

Patent Owner argues that Froitzheim and Gan teach away from each other, because “with regard to the temperatures to use to drive in dopants they direct the POSITA to take opposite paths.” PO Resp. 50. Patent Owner maintains that it “is irrelevant that Gan does not expressly discourage use of high anneal temperatures,” because “Gan shows that the J_o increases too high as the temperature increases above 900°C, yet Froitzheim requires annealing temperature at 900°C and above.” *Id.* at 51. Thus, even though “the temperatures taught by Gan and Froitzheim may meet at a point in the road,” Patent Owner argues, “one teaches to go south from there and the other says to go north.” *Id.* at 51–52.

Petitioner argues that Patent Owner “does not meet the high threshold required to establish teaching away” because a “mere indication of what is

‘optimal or standard does not criticize, discredit, or otherwise discourage investigation into other compositions’ and does not constitute teaching away.” Pet. Reply 12 (citing *Galderma Labs. v. Tolmar*, 737 F.3d 731, 739 (Fed. Cir. 2013); *UCB v. Actavis Labs. UT*, 65 F.4th 679, 692 (Fed. Cir. 2023)). Petitioner explains further why Patent Owner’s reliance on various case law is misplaced. *Id.* at 12–13.

The standard for demonstrating teaching away is, as Petitioner notes, high. “A reference may be said to teach away when a person of ordinary skill, upon reading the reference, would be discouraged from following the path set out in the reference, or would be led in a direction divergent from the path that was taken by the [inventor].” *In re Gurley*, 27 F.3d 551, 553 (Fed. Cir. 1994). Under that standard, Patent Owner’s “teaching away” argument is unavailing. The permitted temperatures in Froitzheim include a range of 900°C-1200°C, which expresses a permitted range, rather than a discouragement or divergence from that range, and the Froitzheim range clearly encompasses the temperatures used by Gan. A reference will also “teach away” if it suggests that the developments flowing from its disclosures are “unlikely to produce the objective of the applicant’s invention,” which is not the case here. *See, e.g., Syntex (U.S.A.) LLC v. Apotex, Inc.*, 407 F.3d 1371, 1380 (Fed. Cir. 2005). The record demonstrates that Gan’s teachings are consistent with Froitzheim’s and, in the proposed combination, likely to produce the desired objective. Pet. Reply 13. In sum, the evidence of record here does not support a conclusion that Froitzheim criticizes or discredits the use of the lower temperatures in its expressly stated range, or that an ordinarily skilled artisan would have been discouraged from considering the full range of Froitzheim’s identified

temperatures. Nor does it support a conclusion that Gan's temperature, which is within Froitzheim's range of temperatures, amounts to a criticizing, discrediting, or discouraging that would constitute a teaching away.

d) Claims 10 and 11

Petitioner asserts that claims 10 and 11 would have been obvious over the combination of Froitzheim and Gan. Pet. 3, 39–54. Patent Owner does not separately address claims 10 and 11 beyond what is argued for independent claim 9. *See generally* PO Resp. Upon review of the full trial record, and arguments and evidence therein, we determine that Petitioner has demonstrated by a preponderance of the evidence that each of the limitations recited in claims 10 and 11 are suggested by the above-identified prior art and that the skilled artisan would have had reason to make the combination with a reasonable expectation of success.

e) Claim 12

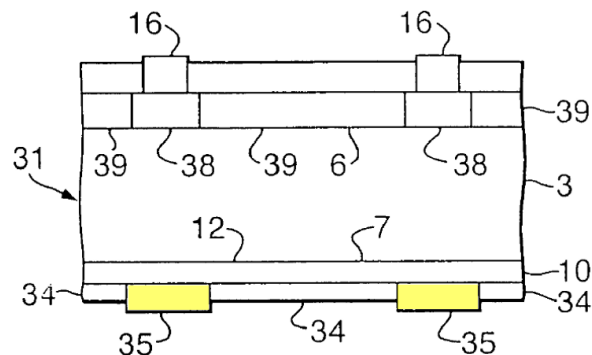
Claim 12 requires: “wherein the second metal contact comprises silver formed over a layer of silicon dioxide.” Ex. 1001, 6:63–65. Neither party proposes an express claim construction of “formed over” or “over.” *See, e.g.*, Pet. 10; PO Resp. 37 (Patent Owner “applies the plain and ordinary meaning of claim terms”), 52–55; Pet. Reply 14–15; PO Sur-reply 15–17; *see also* Tr. 40:11–12 (Patent Owner's counsel stating: “I don't think we need to construe it. I think formed over means formed on top of or formed over.”), 47:13 (Petitioner's counsel stating: “There's no construction needed here.”).

We agree that no express claim construction is required. Applying the plain and ordinary meaning of “formed over,” we find that Froitzheim does

not disclose the formation of a second, silver metal contact formed over a layer of silicon dioxide.

Preliminarily, we agree that the Petition sufficiently explains its rationale for the proposed combination of Froitzheim (and its Figure 3 embodiment) with Gan. Pet. Reply 14 (citing Pet. 55–57; Ex. 1003 ¶¶ 179–182). Dr. Banerjee testifies that in the combination of Froitzheim’s third embodiment with Gan, “metal rear contacts ‘may be formed *after* a passivation layer of silicon dioxide is deposited,’ *i.e.*, after the formation of the oxide layer.” *Id.* (citing Ex. 1003 ¶ 180–181). To the extent Patent Owner maintains that the Petition does not establish a motivation to combine Froitzheim’s Figure 3 embodiment with Gan, we are persuaded by Petitioner’s arguments and Dr. Banerjee’s testimony. Pet. 57; Ex. 1003 ¶ 182 (discussing motivation to combine); Pet. Reply 14.

However, on this complete record, Petitioner has not shown that Froitzheim’s third embodiment has metal contacts that are “formed over” a layer of silicon dioxide. Petitioner relies on Froitzheim’s annotated Figure 3, reproduced below.



Petitioner’s annotated Figure 3 of Froitzheim, shown above, depicts rear contacts 35 and passivation layer 34 on the rear surface of solar cell 31. Pet. 56 (citing Ex. 1006 ¶¶ 19, 30, 33, Fig. 3). Petitioner argues that

passivation layer 34 may be silicon dioxide and rear contacts 35 may be a metal such as silver. *Id.* at 55–56 (citing Ex. 1006 ¶¶ 20, 33, 49, 60).

However, Froitzheim provides that “rear contacts 35 are arranged in a finger structure covering only part of the rear side.” Ex. 1006 ¶ 33.

Importantly, Froitzheim also provides: “Between the fingers a passivation layer 34 is arranged.” *Id.* These disclosures, together with the depiction in Froitzheim’s Figure 3, clearly position the passivation layer 34 between the rear contacts 35 and, correspondingly, position the rear contacts 35 between the passivation layer 34. According to these disclosures, neither is “over” or “formed over” the other.

Petitioner also argues that Froitzheim provides: “Passivation and antireflection coating can be applied using known methods, before or after contact formation.” Ex. 1006 ¶ 50 (cited at Pet. 56–57). According to Petitioner, “the second metal contacts (35) are also formed over a silicon dioxide layer (34) in Froitzheim because it disclosed that the rear contacts may be formed *after* a passivation layer of silicon dioxide is deposited.” Pet. 56–57 (citing Ex. 1006 ¶¶ 19, 33, 50; Ex. 1003 ¶ 181). Patent Owner argues that this “improperly equates Froitzheim’s disclosure of its rear contacts 35 forming *after* the passivation layer with the claim 12 limitation of ‘silver form[ing] *over* a layer of silicon dioxide’” and that “Froitzheim in fact discloses and illustrates that its passivation layer 34 is arranged *between* the rear contact 35 fingers.” PO Resp. 53. We agree with Patent Owner. Although Froitzheim provides generally that a passivation coating can be applied “before or after contact formation” (Ex. 1006 ¶ 50), this does not persuasively contravene the specific disclosures of Froitzheim’s Figure 3 and paragraph 33, which place the rear contacts 35 between the passivation

layer 34, not over. As Patent Owner argues, “forming after does not mean forming over,” and we agree that “Petitioner has not pointed to any description in Froitzheim to suggest that its metal contacts are formed over the passivation layer.” PO Sur-reply 15. Petitioner does not point to any way in which the passivation layer 34 is shown by Froitzheim to be under the rear contacts 35, such that the rear contacts 35 would be over the passivation layer 34, whether the “passivation . . . coating” is applied “before or after contact formation.” Ex. 1006 ¶ 50. Patent Owner’s description of the process of Froitzheim’s metal contact formation using squeegee paste also supports that Froitzheim’s process does not result in metal contacts “formed over” a layer of silicon dioxide. PO Resp. 53–54 (citing Ex. 1006 ¶ 49, Ex. 2020 ¶ 211). Patent Owner describes that, in Froitzheim, the “squeegee paste pierces the passivation layer to reach the emitter layer 10 to form the electrical contact” *Id.* (citing Ex. 2020 ¶ 211). This is consistent with the depiction in Froitzheim’s Figure 3 and the “between” language in Froitzheim paragraph 33.

It is Petitioner’s burden to establish facts supporting its challenge that claim 12 would have been obvious over the combined teachings of Froitzheim and Gan by a preponderance of the evidence. 35 U.S.C. § 316(e); *see also Harmonic, Inc.*, 815 F.3d at 1363. After considering the parties’ arguments and evidence of record, and weighing the testimony, we are not persuaded that Petitioner meets its burden of establishing, by a preponderance of the evidence, that the proposed combination of Froitzheim and Gan teaches or suggests the limitations of claim 12.

f) Conclusion

For these reasons, we determine that Petitioner establishes by a preponderance of the evidence that independent claim 9, and claims 10 and 11 that depend therefrom, would have been obvious over the combined teachings of Froitzheim and Gan. However, we determine that Petitioner does not establish by a preponderance of the evidence that claim 12 would have been obvious over the combined teachings of Froitzheim and Gan.

E. Asserted Obviousness over Froitzheim and Kwark

Petitioner contends that claims 9–12 would have been unpatentable as obvious in view of Froitzheim and Kwark. Pet. 57–64.

1. Overview of Kwark

Kwark describes tests on polysilicon films with and without a chemically grown oxide layer (referred to as “chemox”). Kwark explains that reducing the emitter saturation current (J_{oe}) “translates into potential improvements of energy conversion efficiency for solar cells and enhanced high frequency performance of bipolar structures.” Ex. 1008, 742. Kwark determines from its tests that for polysilicon emitters, the absence of chemox does not “greatly impact J_{oe} ,” but the addition of the chemox “greatly decreases the J_{oe} .” Ex. 1008, 743, Fig. 4.

2. Analysis

Petitioner contends that Froitzheim and Kwark teach or suggest each limitation in claims 9–12. Similar to its challenge based on Froitzheim and Gan, for this challenge Petitioner contends Froitzheim discloses all elements of these claims except for the oxide layer between the emitter and substrate in claim 9, and the polysilicon emitter in claim 11. Pet. 63. Petitioner contends that Kwark discloses using a polysilicon emitter layer and an

intervening oxide layer between the emitter layer and substrate. Pet. 58–59 (citing Ex. 1008, 742, Fig. 4; Ex. 1003 ¶¶ 186–187).

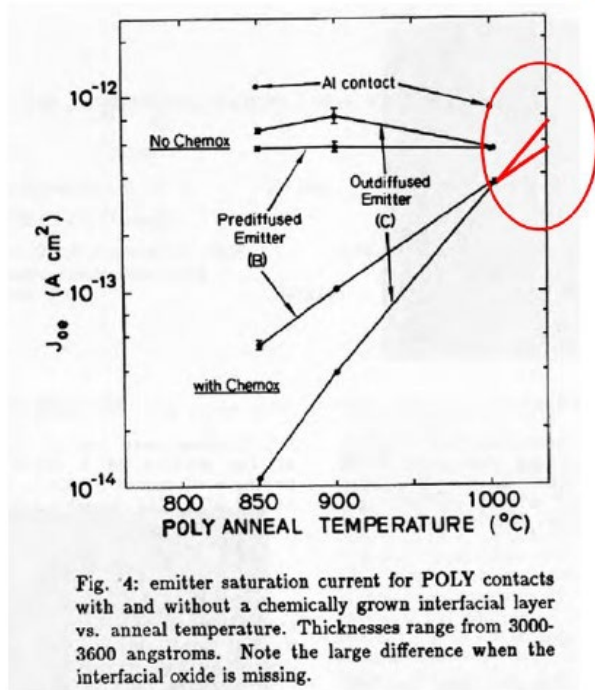
Petitioner argues that a person of ordinary skill in the art would have had reason to modify Froitzheim’s emitter to be a polysilicon emitter with an oxide layer because Kwark teaches the modification would be an improvement. Pet. 60. Petitioner contends Kwark discloses that using a pure polysilicon emitter produced “good results” similar to other emitters, and that the addition of an interfacial chemically grown oxide layer (chemox) between the polysilicon emitter and the substrate can lead to “potential improvements of energy conversion efficiency for solar cells.” Pet. 60–61 (quoting and citing Ex. 1008, 742, 745). Petitioner further contends that a person of ordinary skill in the art would have had a reasonable expectation of successfully combining the teachings of Froitzheim and Kwark to achieve the claimed invention because it involved an arrangement of old elements with each performing the same function it had been known to perform. Pet. 62.

As with the Froitzheim and Gan combination discussed above in Ground 1, Patent Owner does not challenge Petitioner’s allegations regarding the teachings of Froitzheim and Kwark with respect to elements of the challenged claims. *See generally* PO Resp. Rather, Patent Owner responds that Petitioner fails to show why a POSITA would have been motivated to combine Froitzheim and Kwark in the manner proposed by Petitioner. PO Resp. 56–61.

a) *Reasonable Expectation of Success*

(1) *annealing temperatures*

Patent Owner posits: “One feature of Kwark is the use of a Chemox layer, which Kwark teaches only works at low temperature anneals.” PO Resp. 56 (citing Ex. 1008, 742). Patent Owner again notes that Froitzheim teaches a range of 900–1200 °C, preferably between 1000–1100 °C. *Id.* at 57 (citing Ex. 1006 ¶ 42). “In other words, at the temperatures Froitzheim says should be used to drive in the dopant, the benefits alluded to by Kwark would be lost. EX2020, ¶217.” *Id.* Patent Owner explains that “[s]imilar to Gan, Kwark disclosed a desirable J_{oc} value of 2×10^{-14} A/cm²” and “higher-than-desired J_{oc} values at anneal temperatures of 900 °C and above.” *Id.* (citing Ex. 1008, Abstr., 743). Relying on its annotated Figure 4 of Kwark, reproduced below, Patent Owner argues that “given the rapid breakup of the interfacial oxide layer at temperatures above 850°C, as taught by Kwark, and the much higher temperatures taught as being preferable by Froitzheim, a POSITA would not have a reasonable expectation of success in the combination of Froitzheim and Kwark.” *Id.* at 59 (citing Ex. 2020 ¶¶ 222, 199).



Kwark Figure 4 above, reproduced with annotations by Patent Owner, shows a graph of “emitter saturation current for POLY contacts with and without chemically grown interfacial layer vs. anneal temperature.” Ex. 1008, Fig. 4.

We do not share Patent Owner’s concerns. Although Kwark’s Figure 4 may show that higher temperature annealing reduces the effects of an oxide layer, it appears to suggest that polysilicon emitters with an oxide layer (“with Chemox”) still show improved performance (i.e., lower J_{oe} values) over polysilicon emitters without an oxide layer (“No Chemox”). Ex. 1008, Fig. 4; Pet. Reply 17 (stating that “though it is true that Kwark’s Figure 4 shows that J_0 increases with anneal temperature, Figure 4 actually shows that a polysilicon emitter ‘with Chemox’ has a lower J_0 than one with ‘no chemox,’ even up to 1000°C”); *see also* Ex. 1066, 82:8–11, 84:18–21 (explaining that the “with Chemox” samples have a lower recombination than the “no Chemox” samples). Kwark expressly states that the “[a]ddition

of the chemox *greatly decreases* the J_{oc} as has been previously reported.” Ex. 1008, 743 (emphasis added); *see also id.* at 745 (noting “the large difference when the interfacial oxide is missing”); *see* Ex. 2023, 67:7–16 (stating that “even up to thousand degrees it’s beneficial because you get a lower J_{nought} compared to the no chemox case”). Further, Patent Owner overlooks evidence that shows replacing the diffused emitter with a polysilicon emitter with interfacial oxide further improves cell performance. Ex. 1008, 745 (comparing the A1 contact diffused emitter with the polysilicon emitters B and C and indicating a lower J_{oc} for the polysilicon emitters). Moreover, the record evidence suggests that the skilled artisan would have had a reasonable expectation of success in the combination of Froitzheim and Kwark by selecting an annealing temperature of between 900 and 1000 °C in order to balance a lower J_0 with drive-in dopant. *See* Ex. 1006 ¶ 42 (describing doping at a temperature of between 900 to 1200 °C); Ex. 1008, 743 (describing “severe” outdiffusion at 1000° C); Ex. 1067 ¶ 33 (stating that “a Skilled Artisan would know that the benefits to J_0 can be achieved by simply annealing the device at 900°C, which is included in Froitzheim’s temperature range, as I discussed above in relation to Gan”).

(2) *thin oxide layer growth*

Patent Owner further argues that Kwark proposes using Chemox, which is “a very crude form of creating silicon dioxide” and that “the Gan Thesis disparages the use of Chemox.” PO Resp. 59–60 (citing Ex. 2020 ¶ 222–224). Thus, “a POSITA would not have had a reasonable expectation of success in using this Chemox layer, and for this reason would not have

been motivated to combine the Chemox layer and polysilicon layer of Kwark with Froitzheim. EX2020, ¶224.” *Id.* at 60.

We are convinced by Petitioner’s argument and evidence in this regard. Specifically, Petitioner argues that Patent Owner’s “claim that Kwark’s chemical oxide (‘chemox’) ‘only works’ at low temperature anneals is a mischaracterization of the reference.” Pet. Reply 16. Petitioner responds that Chemox is a “very standard procedure” and it was “well within the knowledge of a POSITA to reliably grow a thin chemox layer.” *Id.* (citing Ex. 2023, 57:3–9, 58:3–59:1; Ex. 1067 ¶¶ 39–40). We also credit Petitioner’s argument regarding the Gan Thesis’s alleged disparagement of Chemox (stating that a particular result obtained using Chemox “would be intolerable”) “was made in the context of concentrator cells.” *Id.* at 20. Because the requirements for non-concentrator cells “are less stringent than concentrator cells” we understand that this statement from the Gan Thesis, made in the context of concentrator cells, would not necessarily dissuade one of ordinary skill in the art from using chemox in one sun solar cells. *Id.* Furthermore, while the Gan Thesis seems to favor thermal oxide growth, describing it as “robust during high temperature anneals,” it does not state that chemical oxide layers could not be formed. *See generally* Ex. 2003. And, Kwark details “great[] decreases” in J_{oc} values between 900 and 1000 °C when comparing polysilicon emitters and diffused emitters, with and without Chemox. Ex. 1008, 743, 745 (Fig. 4). On this complete record, we are persuaded by Petitioner’s showing that Chemox would have been a sufficiently standard and reliable procedure to enable one of ordinary skill in the art to “achieve a successful one sun solar cell based on the Froitzheim-Kwark combination.” *Id.* at 17.

b) Reason to Combine

Patent Owner asserts: “For the reasons discussed in the section above, *i.e.*, a POSITA would not have a reasonable expectation of success in the Froitzheim and Kwark combination, a POSITA would have lacked motivation to combine the references.” PO Resp. 60.

Patent Owner’s arguments above rely on a lack of reasonable expectation of success as the basis for its assertion that the ordinarily skilled artisan would not have had a reason to combine the teachings of Froitzheim and Kwark in the manner suggested by Petitioner. PO Resp. 56–60. Because we rejected Patent Owner’s arguments based on reasonable expectation of success above, we similarly reject Patent Owner’s arguments here for the same reasons.

Patent Owner also asserts that because “the use of intentionally broken SiO₂ layers would be a significant cause of concern for long-term performance degradation” (PO Resp. 61); because the Gan Thesis points out that “reproducibility using Chemox is very difficult” (*id.*); and because of “the incompatibility in temperature ranges taught in Froitzheim and Kwark for driving in the dopants,” one of ordinary skill in the art would not be motivated to combine the references (*id.*).

We agree with Petitioner that this single-paragraph argument from Patent Owner is “conclusory” and lacking support for Patent Owner’s purported concerns with long-term performance degradation or reproducibility of Chemox. Pet. Reply 21–22 (criticizing PO Resp. 60–61 and Ex. 2020 ¶ 227 as providing no support). To the extent we consider Patent Owner’s arguments as presented in this paragraph, we find that Petitioner’s arguments regarding the sufficiency of Chemox and its role in

the proposed combination of Froitzheim and Kwark are explained with support from the record. *Id.* (citing Ex. 1008, 745). As we explained above, the ordinarily skilled artisan, considering the teachings of Froitzheim and Kwark, would have selected an annealing temperature of between 900 °C and 1000 °C in order to balance preferences for a lower J_0 with an effective dopant drive-in. *See* Ex. 1006 ¶ 42; Ex. 1007, 743; Ex. 1067 ¶ 33.

Accordingly, we are persuaded that Petitioner has shown that the ordinarily skilled artisan would have had a reason to combine the teachings of Froitzheim and Kwark with a reasonable expectation of success.

c) Alleged Incompatibility

Patent Owner argues that a “POSITA would not have combined Froitzheim with Kwark because their conflicting annealing temperatures show their incompatibility as discussed in § IX.A.1 [addressing reasonable expectation of success in combining Froitzheim and Kwark]” and this “analysis is similar to that discussed above with regard to the Froitzheim and Gan combination in § VIII.C [addressing alleged teaching away].” PO Resp. 61. We have already addressed the arguments discussed in § IX.A.1, *supra*, and have no additional arguments from Patent Owner as to how its argument of incompatibility here would change our analysis above. We are presented with scant reasoning here as to how the Gan and Froitzheim “teaching away” argument is “similar” to the Kwark and Froitzheim “incompatibility” argument and, therefore, have insufficient basis to assess and evaluate what Patent Owner might mean when it asserts the “analysis is similar.” To the extent it may be, we have addressed it *supra*.

d) Claims 10 and 11

Petitioner asserts that claims 10 and 11 would have been obvious over the combination of Froitzheim and Kwark. Pet. 3, 57–64. Patent Owner does not separately address claims 10 and 11 beyond what is argued for independent claim 9. *See generally* PO Resp. Upon review of the full trial record, and arguments and evidence therein, we determine that Petitioner has demonstrated by a preponderance of the evidence that each of the limitations recited in claims 10 and 11 are suggested by the above-identified prior art and that the skilled artisan would have had reason to make the combination with a reasonable expectation of success.

e) Claim 12

Regarding claim 12, the parties' arguments are premised on the same arguments presented for the challenge to claim 12 based on Froitzheim and Gan. PO Resp. 61–62; Pet. Reply 22. For the same reasons given in connection with the challenge to claim 12 based on Froitzheim and Gan, we find that Petitioner has not met its burden of demonstrating that Froitzheim discloses the limitations of claim 12, and we are directed to nothing in the proposed combination of Froitzheim and Kwark that would satisfy this shortcoming.

f) Conclusion

For these reasons, we determine that Petitioner establishes by a preponderance of the evidence that independent claim 9, and claims 10 and 11 that depend therefrom, would have been obvious over the combined teachings of Froitzheim and Kwark. However, we determine that Petitioner does not establish by a preponderance of the evidence that claim 12 would have been obvious over the combined teachings of Froitzheim and Kwark.

F. Asserted Obviousness over Froitzheim and Borden

Petitioner contends that claims 9–12 would have been unpatentable as obvious in view of Froitzheim and Borden. Pet. 65–68.

1. Overview of Borden

Borden is directed to an improved structure for solar cells that includes forming a masking oxide layer on the front and back of the cell and patterning holes in the oxide layer. Ex. 1009, Abstr. Borden teaches that an HIT cell structure (heterojunction with intrinsic thin layer) or polysilicon emitter solar cell structure can be formed over the patterned oxide to create a cell junction in the areas where holes have been cut. Ex. 1009 ¶ 8. Borden states:

Benefits of the invention include that it provides a controlled interface for the HIT cell through insertion of a thin tunnel oxide. Moreover, the tunnel oxide prevents epitaxial growth of amorphous silicon, allowing it to remain amorphous for the optimum band structure. Still further, it provides a layer to protect the surface from plasma damage during deposition of the a-Si layer. Further, it may be used in conjunction with a point contact structure to further increase efficiency.

Ex. 1009 ¶ 8.

2. Analysis

Petitioner contends that Froitzheim and Borden teach or suggest each limitation in claims 9–12. Similar to its challenge based on Froitzheim and Gan, for this challenge Petitioner contends Froitzheim discloses all elements of the challenged claims except for the oxide layer formed between the back surface of the substrate and the emitter layer in claim 9, and the polysilicon emitter in claim 11. Pet. 67. Petitioner contends that Borden discloses “that tunnel oxides can be used between a heavily doped or insulating layer of

polysilicon and a crystal silicon substrate, forming a polysilicon emitter solar cell.” Pet. 67 (quoting Ex. 1009 ¶ 16).

Regarding motivation to combine, Petitioner first asserts that Froitzheim and Borden are analogous art (Pet. 65), and then argues:

The Skilled Artisan would have been motivated to replace Froitzheim’s emitter with a polysilicon emitter with an oxide layer because polysilicon emitter increases solar cell efficiency as previously taught by Gan and Kwark and Borden further taught that the oxide layer “prevents epitaxial growth,” allowing for “optimum band structure” and “provides a layer to protect the surface from plasma damage.” EX1009, Abstract, ¶8; EX1003, ¶199. The teachings of Gan, Foglietti, Kwark, and Borden discussed in §§X.B.1, XI.B, and XII.A would similarly have motivated the Skilled Artisan to integrate a polysilicon emitter with interfacial oxide layer. EX1003, ¶199.

Pet. 66.

Patent Owner responds that Petitioner fails to show why a POSITA would have been motivated to combine Froitzheim and Borden, because the “proposed Froitzheim-Borden combination uses polysilicon emitters, but Borden’s purported benefits are not directed to polysilicon emitter cells, but to Heterojunction with Intrinsic Thin-layer (HIT) solar cells, which features amorphous silicon layers on both sides of a substrate.” PO Resp. 62.

According to Patent Owner, “the purported benefit of the thin tunnel oxide [in Borden] is solely related to amorphous silicon, and amorphous silicon is not present in the proposed Froitzheim-Borden combination.” *Id.* at 65.

Patent Owner also argues, with respect to claim 12, that the proposed combination does not include a “second metal contact” with “silver formed over a layer of silicon dioxide.” *Id.* at 65–66.

Petitioner replies that a POSITA would have been motivated to combine Froitzheim and Borden, which does not apply only to amorphous silicon. Pet. Reply 23–24. Petitioner relies on Dr. Banerjee’s testimony that even if “you didn’t have amorphous silicon, instead have polysilicon, you would help minimize the epitaxial growth of the polysilicon” and “the presence of the interfacial oxide would help minimize any plasma damage, if you’re doing plasma enhanced deposition” (Ex. 2023, 152:6–15); as well as that “a lot of the benefits transfer from amorphous silicon to polysilicon” (*id.* at 145:1–12). Pet. Reply 24. Petitioner adds: “Further, Borden’s additional stated benefit of increased efficiency with a point contact structure is not limited to amorphous silicon.” *Id.* (citing Ex. 1009 ¶ 8; Ex. 1066, 120:23–121:1). Finally, Petitioner replies that the Froitzheim-Borden combination satisfies claim 12. *Id.* at 25.

Patent Owner responds that Petitioner’s theory based on Froitzheim and Borden is unsound, because “the motivation that Petitioner references is limited only to Borden’s amorphous silicon HIT (heterojunction with intrinsic thin layer) structure, which is a structure not addressed in the contested claims.” PO Sur-reply 23–24. Patent Owner points to the Petition as relying on “Borden’s Abstract to establish motivation,” but argues that Borden’s Abstract “clearly limits the benefits that Petitioner relied on to only HIT cells and their use of amorphous silicon,” which “is not present in the proposed Froitzheim-Borden combination.” *Id.* at 24 (citing Pet. 66; Ex. 1009, Abst., ¶ 8; Ex. 1003 ¶ 199); PO Resp. 65. Patent Owner criticizes Petitioner’s argument involving a point contact structure as “improper and incomplete.” *Id.* at 26.

In the Institution Decision, the Board determined that Patent Owner’s arguments at the institution stage “have merit, and raise questions of material fact best left for resolution at trial.” Inst. Dec. 22. Those arguments were directed to “whether Borden’s purported benefits of using an oxide layer would apply to Froitzheim.” *Id.* The complete statement from Borden referenced in the Institution Decision discussion reads: “the tunnel oxide prevents epitaxial growth of amorphous silicon, allowing it to remain amorphous for the optimum band structure. Still further, it provides a layer to protect the surface from plasma damage during deposition of the a-Si layer.” Ex. 1009, Abstr. In the Institution Decision, we noted that this language suggests Borden’s benefits are directed to use of oxides with an a-Si layer, not a polysilicon layer, which is used in Petitioner’s proposed combination. Inst. Dec. 22. The Board also indicated that “clarification or explanation of Borden’s disclosure of masking oxides and tunnel oxides would be helpful to the resolution of this challenge.” *Id.*

On this complete record, we are not persuaded that Petitioner has sufficiently supported its reasoning for the proposed Froitzheim-Borden combination. Although the first sentence in Borden’s Abstract states that the “present invention relates to improved HIT type or polysilicon emitter solar cells” (Ex. 1009, code (57)), the specific teachings of Borden on which Petitioner relies are directed to HIT type cells. *See, e.g.*, Pet. 66 (asserting that Borden’s “oxide layer ‘prevents epitaxial growth,’ allowing for ‘optimum band structure’ and ‘provides a layer to protect the surface from plasma damage.’”). These quotes from the Petition are taken directly from Borden’s Abstract and paragraph 8. Ex. 1009, code (57) (“Moreover, the **tunnel oxide prevents epitaxial growth** of amorphous silicon, allowing it

to remain amorphous for the **optimum band structure**. Still further, it **provides a layer to protect the surface from plasma damage during deposition of the a-Si layer.**”) (emphasis added), ¶ 8 (same language). The quotes relate to a tunnel oxide as applied to amorphous silicon and, thus, “the motivation that Petitioner references is limited only to Borden’s amorphous silicon HIT (heterojunction with intrinsic thin layer) structure, which is a structure not addressed in the contested claims.” PO Sur-reply 24. The discussion in Borden’s Abstract and in the paragraphs of Borden relied upon by Petitioner in its Petition emphasize tunnel oxides and their benefits for HIT cells, which are not polysilicon emitter solar cells, and to amorphous silicon, which Patent Owner argues would not be present in Petitioner’s proposed combination. Ex. 1009, code (57), ¶¶ 8, 20; PO Resp. 64 (citing Ex. 2023, 138:21–139:20).

In the Institution Decision, we requested “clarification or explanation of Borden’s disclosure of masking oxides and tunnel oxides” to help resolve this challenge. Inst. Dec. 22. Petitioner has not clearly explained on this complete record how the masking oxide and tunnel oxide distinction in Borden is supportive of, rather than unhelpful to, Petitioner’s reasoning to combine. Nor are we persuaded by Petitioner’s reliance on Dr. Banerjee’s testimony; although “Dr. Banerjee tried to cover these benefits to the deposition of the polysilicon layer,” “these benefits are not stated by the prior art references themselves, nor does Petitioner show that polysilicon is being deposited by plasma-enhanced deposition as they said.” Tr. 39:12–15. Finally, regarding Petitioner’s “point contact structure” argument presented in its Reply, we agree with Patent Owner that not only was this not presented

in the Petition, it is insufficiently explained in the Reply to provide a basis to combine Froitzheim and Borden. PO Sur-reply 26; Pet. Reply 24.

Regarding claim 12, the parties' arguments are premised on the same arguments presented for the challenge to claim 12 based on Froitzheim and Gan. PO Resp. 65–66; Pet. Reply 25. For the same reasons given in connection with the challenge to claim 12 based on Froitzheim and Gan, we find that Petitioner has not met its burden to demonstrate that Froitzheim discloses the limitations of claim 12, and we are directed to nothing in the proposed combination of Froitzheim and Borden that would satisfy this shortcoming.

For the reasons set forth above, we determine that Petitioner does not establish by a preponderance of the evidence that claims 9–12 would have been obvious over the combined teachings of Froitzheim and Borden.

G. Asserted Obviousness over Meier, Okayasu, Borden, and Jordan

Petitioner contends claims 9–11 would have been unpatentable as obvious in view of Meier, Okayasu, Borden, and Jordan. Pet. 22–34. Petitioner directs us to portions of these references that purportedly teach or suggest the limitations recited in these claims. Pet. 25–34. Petitioner contends that a person of ordinary skill in the art would have had reason to modify Meier to include a polysilicon emitter (as taught by Okayasu) and an oxide layer (as taught by Borden). Pet. 23–24. In support, Petitioner directs us to statements made by the PTAB when addressing the appeal during prosecution of U.S. App. No. 14/504,771 (“the ’771 Application”), a continuation of the ’516 patent. Pet. 9, 23–24. According to Petitioner, the “previous conclusion of the Examiner and the PTAB were correct, and in

this proceeding the PTAB should come to the same conclusion for the same reasons, as Dr. Banerjee explains. EX1003, ¶¶86-95.” Pet. 24.

Patent Owner argues that Petitioner’s combination “uses polysilicon emitters, but Borden’s purported benefits are directed to HIT cells, not polysilicon emitter cells.” PO Resp. 38 (citing Pet. 23). “In other words, the purported benefit of the thin tunnel oxide is solely related to amorphous silicon, and amorphous silicon is not present in the proposed Meier-Okayasu combination” and, therefore, “a POSITA would not have been motivated to insert Borden’s tunnel oxide layer (unclear whether this is CSI’s proposed ‘interfacial oxide layer’) on the proposed Meier-Okayasu combination because Borden’s purported benefits would not have been applicable.” *Id.* at 39 (citing Ex. 2020 ¶ 182).

Petitioner does not present arguments directed to the Meier-based grounds in its Reply. *See generally* Pet. Reply. Patent Owner presents no further arguments directed to the Meier-based grounds in its Sur-reply. *See generally* PO Sur-reply. At oral hearing, Petitioner stated:

Petitioner is maintaining Grounds 1 and 2 for the argument that collateral estoppel should apply and the claims should be invalidated based on those combinations given that the Patent Office used those combinations to invalidate substantially similar claims. In Petitioner’s view, this is really a question for appeal and a legal question as though there’s nothing further to clarify on the record beyond what’s been submitted in the briefing.

Tr. 5:19–25.

In the Institution Decision, the Board stated: “Petitioner presents a challenge based on previous conclusions of an Examiner and the Board when addressing different claims in a different patent.” Inst. Dec. 27 (citing

Pet. 23–24). The Board further noted that it is “Petitioner’s burden to identify and explain the evidence that supports the challenge to each claim.” *Id.* (citing 37 C.F.R. § 42.22(a)(2) (“Each petition or motion must be filed as a separate paper and must include . . . (2) A full statement of the reasons for the relief requested, including a detailed explanation of the significance of the evidence including material facts, and the governing law, rules, and precedent.”)). At that stage, Petitioner had not provided any authority establishing that Petitioner may rely on findings of an Examiner or a Board decision involving different claims from a different patent application to satisfy its evidentiary burdens in this proceeding. *Id.* On this record, Petitioner has not rectified this shortcoming.

The Institution Decision also stated that “our rules prohibit incorporating arguments by reference from one document into another document. *Id.* (citing 37 C.F.R. § 42.6(a)(3) (“Arguments must not be incorporated by reference from one document into another document.”)). At that stage, Petitioner “improperly attempted to incorporate arguments and evidence from ten paragraphs in Dr. Banerjee’s declaration into the Petition,” and the Board declined to look through Dr. Banerjee’s declaration to identify the arguments and evidence that purportedly supported Petitioner’s challenge. Inst. Dec. 27 (citing Pet. 24). On this complete record, Petitioner has not addressed this matter.

Finally, we note Patent Owner’s un rebutted and declarant-backed arguments that one of ordinary skill in the art would not have been motivated to combine Borden’s tunnel oxide layer with the Meier-Okayasu combination. PO Resp. 39. Patent Owner’s arguments support its position that Borden’s purported benefits are directed to amorphous silicon, which is

not present in the proposed Meier-Okayasu combination, and therefore one of ordinary skill in the art would not have considered Borden's purported benefits to have been applicable to the proposed Meier-Okayasu combination. Ex. 2020 ¶¶ 180–182. Patent Owner's arguments further undermine Petitioner's obligation to meet its burden to prevail on its arguments based on Meier, Okayasu, Borden, and Jordan.

H. Asserted Obviousness over Meier, Okayasu, Foglietti, Gan, and Jordan

Petitioner contends claims 9–11 would have been unpatentable as obvious in view of Meier, Okayasu, Foglietti, Gan, and Jordan. Pet. 34–39. Petitioner directs us to portions of these references that purportedly teach or suggest the limitations recited in these claims. *Id.* Petitioner contends that a person of ordinary skill in the art would have had reason to modify Meier to include a polysilicon emitter (as taught by Okayasu) and an oxide layer (as taught by Foglietti and Gan). Pet. 38–39. In support, Petitioner relies on the same reasons for combining Meier and Okayasu discussed above, and directs us to statements made by the PTAB when addressing the appeal during prosecution of the '771 Application. Pet. 38–39. According to Petitioner, “[t]he PTAB prior findings and conclusions were correct, and it should rule the same in this IPR.” Pet. 39.

Patent Owner argues that “Foglietti’s goal is to form ‘an interfacial oxide with good control which maintains its integrity during subsequent processing,’” but “Gan’s goal, on the other hand, is to break up the interfacial oxide.” PO Resp. 40–41 (citing Ex. 1014 ¶ 10; Ex. 2020 ¶¶ 184–185). “In other words, Foglietti teaches maintaining an interfacial oxide’s integrity to enable majority carrier tunneling, but Gan discloses breaking up the interfacial oxide to create different processes for the majority carriers to

pass through” and, therefore, “a POSITA would not have been motivated to combine the two incompatible references.” *Id.* at 41 (citing Ex. 2020 ¶ 186).

Petitioner does not present arguments directed to the Meier-based grounds in its Reply. *See generally* Pet. Reply. Patent Owner presents no further arguments directed to the Meier-based grounds in its Sur-reply. *See generally* PO Sur-reply. At oral hearing, Petitioner stated:

Petitioner is maintaining Grounds 1 and 2 for the argument that collateral estoppel should apply and the claims should be invalidated based on those combinations given that the Patent Office used those combinations to invalidate substantially similar claims. In Petitioner’s view, this is really a question for appeal and a legal question as though there’s nothing further to clarify on the record beyond what’s been submitted in the briefing.

Tr. 5:19–25.

In the Institution Decision, the Board found Petitioner’s arguments for this ground to be problematic for the same reasons as the first Meier-based ground, namely, failing to identify and explain sufficiently the evidence that supports the challenge to each claim, and pointing to no authority establishing that Petitioner may rely on findings of an Examiner or a Board decision involving different claims from a different patent application for this proceeding. Inst. Dec. 28 (citing 37 C.F.R. § 42.22(a)(2)). On this complete record, Petitioner has not addressed this matter.

Finally, we note Patent Owner’s un rebutted and declarant-backed arguments that one of ordinary skill in the art would not have been motivated to combine Gan’s annealing to break the interfacial oxide “by a very small fracture” with Foglietti’s teaching of maintaining an interfacial oxide’s integrity to enable majority carrier tunneling. PO Resp. 40–41.

Patent Owner’s arguments support its position that Gan and Foglietti are directed to different processes to further different purposes and therefore one of ordinary skill in the art would not have considered Gan’s purported benefits to have been applicable to the Foglietti in the proposed combination. Ex. 2020 ¶¶ 183–186. Patent Owner’s arguments further undermine Petitioner’s obligation to meet its burden to prevail on its arguments based on Meier, Okayasu, Foglietti, Gan, and Jordan.

III. CONCLUSION

After reviewing the parties’ arguments and weighing the evidence offered by both parties, we determine that Petitioner shows by a preponderance of the evidence that claims 9–11 are unpatentable, and does not show by a preponderance of the evidence that claim 12 is unpatentable.

In summary:

Claim(s)	35 U.S.C. §	Reference(s)/Basis	Claim(s) Shown Unpatentable	Claim(s) Not Shown Unpatentable
9–11	103	Meier, Okayasu, Borden, Jordan		9–11
9–11	103	Meier, Okayasu, Gan, Foglietti, Jordan,		9–11
9–12	103	Froitzheim, Gan	9–11	12
9–12	103	Froitzheim, Kwark	9–11	12
9–12	103	Froitzheim, Borden		9–12
Overall Outcome			9–11	12

IV. ORDER

In consideration of the foregoing, it is hereby:

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ORDERED that Petitioner has shown by a preponderance of the evidence that claims 9–11 of the '516 patent are unpatentable;

ORDERED that Petitioner has not shown by a preponderance of the evidence that claim 12 of the '516 patent is unpatentable; and

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

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FOR PETITIONER:

Samuel Tiu
Brooke S. Böll
SIDLEY AUSTIN LLP
stiu@sidley.com
brooke.boll@sidley.com

FOR PATENT OWNER:

Eric Klein
Jeffrey Swigart
Corbin Cessna
Jeremy D. Peterson
Bradford A. Cangro
Jacob A. Snodgrass
Jing Zhao
PV LAW LLP
jeremy.peterson@pvuslaw.com
bradford.cangro@pvuslaw.com
jacob.snodgrass@pvuslaw.com
jing.zhao@pvuslaw.com
eklein@velaw.com
jswigart@velaw.com
ccessna@velaw.com