

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

CANADIAN SOLAR INC.,
Petitioner,

v.

MAXEON SOLAR PTE. LTD.
Patent Owner

Patent No. 8,222,516

Issued: July 17, 2012

Filed: February 20, 2008

Inventor: Peter John Cousins

Title: Front Contact Solar Cell with Formed Emitter

Inter Partes Review No. IPR2024-01039

**PETITION FOR *INTER PARTES* REVIEW OF
U.S. PATENT NO. 8,222,516**

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Attachment A. Proof of Service of the Petition

Attachment B. List of Evidence and Exhibits Relied Upon in Petition

Attachment C. Table of Claims and Elements

Attachment D. Comparison of Challenged Claims to 771/035 Applications

I. INTRODUCTION

Canadian Solar Inc. (“CSI”) respectfully requests that claims 9-12 of U.S. Patent 8,222,516 (“516 Patent”) be cancelled as unpatentable. In two separate continuation applications from the 516 patent, the Examiner rejected claims substantially similar to the 516 Patent claims challenged here. In those two continuation applications, the Examiner relied on newly discovered prior art that rendered the claims obvious. The Examiner’s rejections were appealed to the PTAB, which affirmed both obviousness findings. The PTAB decisions became final agency actions when they were not appealed to the Federal Circuit. Thus, Patent Owner Maxeon is now collaterally estopped from relitigating the obviousness of the claims for a third time.

In this petition, CSI relies on prior art references that were not considered by the Examiner during prosecution of the 516 Patent, but were applied to reject the 516 Patent’s continuation claims mentioned above. Aside from collateral estoppel, claims 9-12 are also independently unpatentable based on these and other prior art references relied upon in this Petition.

II. COMPLIANCE WITH IPR REQUIREMENTS

A. CSI Can Contest The 516 Patent

CSI certifies it is not barred or estopped from requesting *inter partes* review (“IPR”) of the 516 Patent. Neither CSI, nor any party in privity with it, has filed a civil action challenging the validity of any 516 Patent claim. The 516 Patent has

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not been the subject of any prior IPR. This IPR petition is filed within one year of Maxeon serving a complaint alleging infringement of the patent.

B. IPR Fee (37 CFR §42.15(a))

The Director is authorized to charge the fee specified by 37 CFR §42.15(a) to Deposit Account No. 50-1597.

C. Mandatory Notices (37 CFR §42.8(b))

CSI and Canadian Solar (USA) Inc. are the real parties in interest. The 516 Patent is asserted in the following legal proceedings:

- *Maxeon Solar Pte. Ltd. v. Canadian Solar Inc.* 2-24-cv-00210 (ED Texas)
- *Maxeon Solar Pte. Ltd. v. Hanwha Energy Corporation et al*, 2-24-cv-00262 (ED Texas)
- *Maxeon Solar Pte. Ltd. v. REC Solar Holdings AS*, 2-24-cv-00260 (ED Texas)

Lead Counsel is Samuel N. Tiu (Reg. No. 47,997), stiu@sidley.com, 213-896-6095. Backup Counsel are Joseph Micallef (Reg. No. 39,772) jmicallef@sidley.com, 202-736-8492, and Brooke S. Böll (Reg. No. 76,268), brooke.boll@sidley.com, 213-896-6633.

Service on Petitioners may be made by email (Sidley-CSI-IPR@sidley.com), mail or hand delivery to: Sidley Austin LLP, 350 South Grand

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Avenue, Los Angeles, CA 90071. The fax number for lead and backup counsel is 213-896-6600.

Proof of service of this petition is provided in **Attachment A**.

III. IDENTIFICATION OF CHALLENGED CLAIMS

1. Claims 9-11 are obvious in view of Meier, Okayasu, Borden, and Jordan
2. Claims 9-11 are obvious in view of Meier, Okayasu, Gan, Foglietti, and Jordan
3. Claims 9-12 are obvious in view of Froitzheim and Gan
4. Claims 9-12 are obvious in view of Froitzheim and Kwarik
5. Claims 9-12 are obvious in view of Froitzheim and Borden

Attachment B lists the evidence relied upon in this petition.

IV. PERSON OF ORDINARY SKILL IN THE ART

The person of ordinary skill in the art in the 516 Patent's field of solar cell design or manufacture in 2008 ("Skilled Artisan") would have been someone with 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. Alternatively, that person would have had a bachelor's degree in electrical engineering, applied physics, or materials science, and at least

EX1001, 2:28-30, 1:46-48. Between the polysilicon emitter 108 and the substrate 101 is a tunnel oxide layer 107, which “may comprise silicon oxide thermally grown” on the substrate’s surface. EX1001, 2:57-66. Backside metal contact 110 connects with the emitter 108 through contact holes 123 in the silicon dioxide layer 109. EX1001, 2:66-3:2. The solar cell’s front side (top side of FIG. 1) has a texture 113 and a silicon nitride antireflective coating 103. EX1001, 2:22-27, 3:11-21, 4:28-33. Metal contact 102 connects with the substrate through holes in the antireflective coating 103. EX1001, 2:50-53.

C. 516 Patent’s Prosecution

The original claim 9 (application claim 17) recited all elements in issued claim 9 except for “an oxide layer formed between the backside of the substrate and the emitter layer.” EX1002, 19. The Examiner rejected this original claim and found that back-junction solar cells formed with a substrate and an oppositely doped emitter layer were already known in the prior art. Specifically, the Examiner found that Meier (US6,262,359) disclosed a solar cell with an N-type substrate and a P-type emitter layer forming a backside junction with the substrate, and metal contacts on the front and back of the solar cell to electrically connect with the substrate from the front and with the emitter layer from the back. EX1002, 76-78. The Examiner noted that Meier did not disclose texturing the solar cells’ front side (as in application claim 18), nor did Meier disclose that the

emitter layer was polysilicon (as in application claim 19). *Id.* Meier disclosed that the substrate was “single crystal” silicon. EX1011 at 5:31-42. To assert obviousness, the Examiner combined Meier with Jordan (US2005/0268963), which disclosed a solar cell with a textured front surface and a polycrystalline silicon wafer that formed the emitter layer.

To overcome this rejection, the Applicant amended the claims to recite “an oxide layer formed between the back surface of the substrate and the emitter layer.” EX1002, 135. The Applicant argued that because the emitter layer in both Meier and Jordan were emitters that “were formed within the silicon substrate.” EX1002, 138-139. Thus, they allegedly could not have an oxide layer in between. *Id.*

The Examiner allowed the amended claims 17-20 in the application (claims 9-12 of the 516 Patent). The Notice of Allowance explained the reason for allowance: “the prior art of record lacks an oxide layer formed between an emitter and an oppositely doped substrate and a metal contact making an electrical connection to the substrate on the front light incident side of the solar cell.” EX1002, 152.

D. Known Technologies Not Considered by Examiner

Before the 516 Patent, those in the field already recognized that replacing diffused in-substrate emitters with deposited polysilicon emitters would improve

both bipolar transistors and solar cell performance. EX1003, ¶58. Deposited polysilicon emitters with an interfacial oxide layer were first used to improve the performance of bipolar transistors in 1984. EX1003 ¶58 (citing EX1023).

“Interfacial oxide layer” refers to a layer of silicon dioxide between the substrate and polysilicon emitter. EX1003 ¶58.

Around the same time, a number of publications suggested that this polysilicon emitter improvement can be achieved in solar cells as well. *See e.g.*, EX1016, 597 (“There have been a considerable number of reports recently on improved bipolar transistor emitters made of polycrystalline silicon.... Such heterojunctions are valuable not only for emitter efficiency in bipolar transistors, but also for solar cells”); EX1008, 742 (“Incorporation of these films into the emitter structure of an NPN bipolar transistor ... translates into potential improvements of energy conversion efficiency for solar cells....”); EX1003, ¶¶59-60.

Subsequently in 1987, another publication noted that “[i]t is interesting to project what should be possible if the best available emitter technology were applied to point contact cells rather than the diffused emitters from the current process.” EX1017, 2122. The authors modeled the projected efficiencies of what would be possible incorporating “SIPOS” emitters versus diffused emitters, and

showed a more than one percent absolute increase in efficiency for the solar cell.

Id.; EX1003 ¶61.

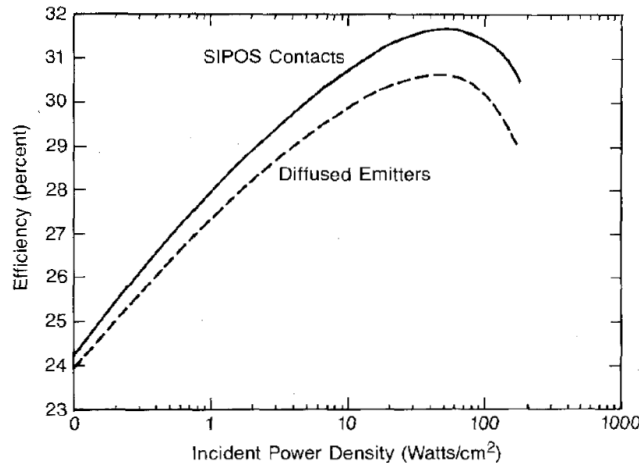


Fig. 9. A comparison of the projected efficiencies possible for a cell incorporating SIPOS emitters (solid curve), compared to projections for diffused emitters as used to date (dashed curve).

“SIPOS” refers to “semi-insulating polysilicon,” which are formed by introducing a small amount of oxygen bearing species into the chemical vapor deposition of polysilicon. EX1003, ¶62. But as researchers found in 1984, even a pure polysilicon emitter layer with a chemically formed interfacial oxide layer led to a “surprising” improvement. EX1008, 84; EX1003, ¶62. Following these suggestions, Gan (detailed below) examined the use of deposited polysilicon emitters with an interfacial oxide layer in concentrator solar cells in 1990 and noted that the “cell performance can be improved if the diffused-emitter is replaced with the polysilicon emitter.” EX1007, 245. Gan also pointed to the earlier 1987 modeling work showing one percent absolute increase in solar cell efficiency for

“backside contact solar cells.” *Id.*, 249. Backside contact solar cells have their PN junction on the back of the solar cells. EX1003, ¶62.

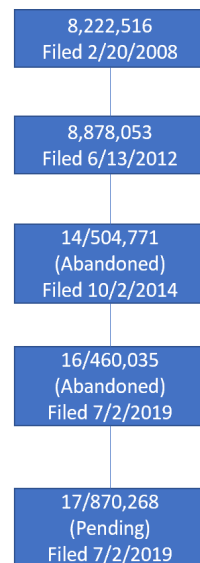
A month before the 516 Patent filing, Peter Borden of Applied Materials filed a provisional application disclosing polysilicon emitter solar cells with an interfacial oxide layer, which also appears in the later filed PCT application:

The present invention relates to improved HIT type or polysilicon emitter solar cells. According to certain aspects, the invention includes forming a masking oxide layer on the front and back of the cell and then patterning holes in the masking oxide. A HIT cell structure or polysilicon emitter solar cell structure is then formed over the patterned oxide,.... . EX1010, Abstract; EX1009, Abstract.

None of these prior art references were before the 516 Patent Examiner.

E. PTAB’s Unpatentability Decisions in Two Continuation Applications

SunPower (who later assigned the 516 Patent family to Maxeon) prosecuted the 516 Patent. After the 516 Patent issued, SunPower filed a series of continuation applications that claimed priority to the 516 Patent. U.S. App. No. 14/504,771 (“771 Application”) and 16/460,035 (“035 Application”) presented claims substantially similar to the 516 Patent’s Claims 9-11. *See* Attachment D.



During prosecution of the 771 Application, the Examiner discovered polysilicon emitter and intervening oxide layer prior art references that she had not

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reviewed when examining the 516 Patent. Based on the newly discovered prior art, the Examiner rejected the 771 Application's claims as obvious based on the combinations of (1) Meier in view of Okayasu, Borden, and Wenham and (2) Meier in view of Okayasu, Foglietti, Gan, and Wenham. EX1005, 447-455.¹

SunPower appealed the rejections to the PTAB (EX1005, 458-499), which affirmed (EX1005, 507-520).

In the subsequent 035 Application, the Examiner again rejected claims that were substantially similar to the 516 Patent claims as obvious based on Meier in view of Okayasu, Borden, Wenham, Jordan, and Xi. EX1018, 208-223.

SunPower again appealed the rejection, which the PTAB again affirmed. EX1018, 208-223.

SunPower *did not* appeal either of the PTAB's decisions to the Federal Circuit, making both PTAB decisions final. EX1005, 522; EX1018, 295.

F. Claim Construction

CSI does not believe that claim construction is necessary to resolve this Petition.

¹ Wenhan is not relevant here as it was used for a limitation not found in the 516 Patent.

VI. DISCRETIONARY DENIAL IS INAPPLICABLE

The PTAB should not deny institution based on Section 325(d) because, aside from Meier and Jordan, none of the obviousness references relied on here were presented during the 516 Patent's prosecution. Indeed, when these references were considered in continuation applications with substantially the same claims, the Examiner rejected the claims, and the PTAB affirmed. See §§V.E and VIII.

The factors set forth in *Apple Inc. v. Fintiv, Inc.*, IPR2020-00019, Paper 11 at 5-6 (PTAB Mar. 20, 2020) also weigh against discretionary denial:

Factor 6: Given the PTAB's prior two affirmance decisions, the merits here are compelling and require institution per the Director's June 21, 2022 memo. EX1026 at 2. As discussed in §VII, these two final PTAB decisions collaterally estop Maxeon from relitigating the challenged claims' unpatentability. The claims are also independently unpatentable. See §§VIII-XII.

Factors 1&2: Maxeon filed suit on March 25, 2024 against CSI in the Eastern District of Texas. The Texas court has not held a scheduling conference nor set a trial date as of this IPR's filing. The presiding Judge Gilstrap has frequently granted stays based on instituted IPRs, with at least 48 stays granted and only 41 denied with prejudice. EX1027.

Furthermore, a recent study confirmed that in over 94% of cases, future trial dates considered by the PTAB in its *Fintiv* analysis do not hold. EX1028. As

Senator Tillis has written to Acting Director Hirshfeld, “the PTAB’s historical practice of crediting unrealistic trial schedules ... has not only produced outcomes that are untethered from the policy underpinnings of the *Fintiv* rule, but [] has also created harmful incentives for forum shopping and inappropriate judicial behavior.” EX1029, 1.

Factor 3: CSI filed this Petition expeditiously, less than three months after Maxeon’s complaint, which favors institution. *SK Hynix Inc. v. Netlist, Inc.*, IPR2020-01042, Paper 14, 14 (PTAB Dec. 17, 2020). By the time an institution decision will be made, little or no substantive proceedings will have occurred in the parallel litigation. It is likely that initial contentions will be exchanged and possibly some Markman briefing will take place. But it is unlikely that substantial investment in the court proceeding will have occurred on invalidity.

Factor 4: CSI stipulates that, if this IPR is instituted, it will not assert in any district court or ITC litigation that any claim at issue in this IPR is invalid on the basis of any ground raised or reasonably could have been raised during this IPR.

Factor 5: CSI is one of the defendants in the district court cases, a fact that should weigh against denial because it permits CSI to provide the §315 stipulation above, thereby avoiding any possibility of duplication.

VII. MAXEON IS COLLATERALLY ESTOPPED FROM RELITIGATING OBVIOUSNESS OF CLAIMS 9-11

In two earlier proceedings, the PTAB ruled that claims substantially similar to Claims 9-11 of the 516 Patent were unpatentable as obvious over Meier in view of Okayasu, Borden, and Jordan, or alternatively Meier in view of Okayasu, Gan, Foglietti, and Jordan. Maxeon is collaterally estopped from relitigating the unpatentability of claims 9-11 because the previously rejected claims were not materially different from the challenged claims in this IPR. *Google LLC v. Hammond Development Int'l*, 54 F.4th 1377, 1381-1382 (Fed. Cir. 2022).

Collateral estoppel applies to IPR proceedings. *Google*, 54 F.4th at 1381. A final agency decision can also serve as the basis for collateral estoppel. *B&B Hardware, Inc. v. Hargis Indus., Inc.*, 135 S. Ct. 1293 (2015) (giving collateral estoppel effect to an earlier TTAB decision). Unlike unappealed examiner rejections, which do not have preclusive effects (*In re Hitchings*, 342 F.2d 80, 85, (CCPA 1965)), a final PTAB decision has preclusive effects under *B&B Hardware*. See *SynQor, Inc. v. Vicor Corp.*, 988 F.3d 1344 (Fed. Cir. 2021) (applying collateral estoppel based on the PTAB's decision in a previous reexamination proceeding). See also, *Gossage v. Merit Sys. Prot. Bd.*, 861 F. App'x 426, 431 (Fed. Cir. 2021) (affirming administrative agency's application of collateral estoppel because the issue was actually litigated in a prior appeal to that same agency).

CSI can invoke collateral estoppel though not a party to the prior proceedings. *Blonder-Tongue Labs., Inc. v. Univ. of Ill. Found.*, 402 U.S. 313 (1971); *Parklane Hosiery Co., Inc. v. Shore*, 439 U.S. 322 (1979). “[N]one of the circumstances that might justify reluctance to allow the offensive use of collateral estoppel is present.” *Parklane*. 439 U.S. at 331. First, CSI could not have joined the earlier PTAB proceedings, just like the plaintiff in *Parklane*. *Id.* at 331-332. Second, Maxeon and its predecessor, SunPower, had every incentive to fully litigate the obviousness issue in the prior proceedings; in fact, it appealed and litigated the issue twice. *Id.* Third, the prior PTAB decisions relied upon for collateral estoppel were “not inconsistent with any previous decision.” *Id.* The 516 Patent claims were issued only because the Examiner did not have the prior art references that he later relied on to reject the claims in the two continuation applications, which the PTAB affirmed. Finally, Maxeon and SunPower had a full and fair opportunity to litigate the obviousness issue of the patent claims and should be collaterally estopped from relitigating them a *third time* in this IPR.

For collateral estoppel to apply, CSI must show that “(1) the issue is identical to one decided in the first action; (2) the issue was actually litigated in the first action; (3) resolution of the issue was essential to a final judgment in the first action; and (4) [Maxeon] had a full and fair opportunity to litigate the issue in the first action.” *Google*, 54 F.4th at 1381. All four elements are met here.

A. The Unpatentability Issue Is Identical

“It is well established that patent claims need not be identical for collateral estoppel to apply.” *Google*, 54 F.4th at 1381. “Rather, collateral estoppel requires the *issues of patentability* to be identical.” *Id.* “Thus, collateral estoppel may apply even if the patent claims ‘use slightly different language to describe substantially the same invention,’ so long as ‘the differences between the unadjudicated patent claims and adjudicated patent claims do not materially alter the question of invalidity.’” *Id.* “Whether the differences between the patent claims materially alter the question of patentability is a legal conclusion based on underlying facts.” *Id.*

Here, there is no material difference between the 516 Patent’s claims 9-11 and the claims rejected in the 771 Application and the 035 Application. The unpatentability issue based on obviousness is the same. CSI relies on the same prior art references that were used to reject the prior claims, which the PTAB affirmed.

1. The Claims Are Substantially Similar

A table showing the rejected claims of the 771 Application and the 035 Application, and claims 9-12 of the 516 patent are set out in Attachment D. The only differences between the 771 Application claims and the challenged claims are

the following additional elements in the challenged claims, none of which are material:

- a textured front surface (claim 1),
- the first and second metal contacts allow for an external circuit to be powered by the solar cell (claim 1), and
- the definition of the substrate to be N-type, while the polysilicon emitter is P-type (claim 11).

The Examiner, as affirmed by the PTAB, has already found that the first and third elements do not present a patentable distinction from the prior art relied on here. EX1018, 235.²

The second element above simply recites a well-known solar cell function and one that is disclosed by the base prior art reference relied on here. EX1003, ¶118. Specifically, the primary reference relied upon by the Examiner and this Petition (i.e., Meier) explained that “[s]olar cells are widely used because they convert easily accessible energy from a light source, such as the sun, to electrical power to operate *electrically driven devices, e.g., calculators, computers, and heaters used in homes.*” EX1011, 1:15-18 (emphasis added). “Calculators,

² The first and third elements were recited by claim 21 of the 035 Application, which was previously rejected based on the same prior art relied on here. EX1018, 235.

computers and heaters” are all external electrical circuit when connected to the solar cell. EX1003, ¶118. The 516 Patent’s “Description of the Background Art” admits that “[s]olar cells are well known devices for converting solar radiation to electrical energy” and “[t]he metal contacts allow an external electrical circuit to be coupled to and be powered by the solar cell.” EX1001, 1:19-30.

Thus, there is no difference between the claims challenged here and the earlier rejected claims that is material to the patentability issue.

2. The Prior Art Is Identical

For its first two grounds, CSI is relying on the same combinations of prior art references the Examiner relied to reject the 771 Application’s and 035 Application’s claims and which the PTAB affirmed on appeal and became final. *See* §§VIII-IX. Thus, the PTAB decided the same unpatentability issue in the two prior proceedings.

B. Maxeon Actually Litigated The Unpatentability Issue

In both prior proceedings, Maxeon appealed the Examiner’s rejections to the PTAB and thus, actually litigated the unpatentability issue twice. Maxeon submitted appeal briefs in both actions laying out its arguments and factual support for why the claims were not obvious. EX1005, 458-471; EX1018, 227-238. The Examiners in both proceedings responded with answering briefs, detailing why each element of the claims was satisfied. EX1005, 478-493; EX1018, 245-266.

Maxeon further replied to the Examiners' answering briefs. EX1005, 494-499; EX1018, 267-270. Thus, in both instances, the PTAB adjudicated the unpatentability issue after full briefings from both Maxeon and the Examiner.

C. The Claims' Unpatentability Was Essential to the Prior PTAB Decisions

Maxeon appealed a single issue to the PTAB in both prior proceedings, and that is the unpatentability of the claims based on obviousness. The PTAB decided that issue against Maxeon. The PTAB decisions became final when Maxeon did not appeal the PTAB decisions. Hence, the unpatentability issue was essential to both PTAB's final decisions and the results of the two proceedings.

D. Maxeon Had a Full and Fair Opportunity to Litigate

"A person who was not a party to a suit generally has not had a 'full and fair opportunity to litigate' the claims and issues settled in that suit." *Taylor v. Sturgell*, 553 U.S. 880, 892 (2008). However, the U.S. Supreme Court has recognized exceptions to this general rule. "[N]onparty preclusion may be justified based on a variety of pre-existing 'substantive legal relationship[s]' between the person to be bound and a party to the judgment." *Id.* at 894. "Qualifying relationships include, but are not limited to, preceding and succeeding owners of property, bailee and bailor, and assignee and assignor." *Id.* (emphasis added).

Here, Maxeon is the assignee and successor in interests to SunPower, the original owner of the 771 and 035 Applications at the time of the PTAB prior

decisions. Maxeon was spun off from SunPower. EX1030. SunPower then assigned to Maxeon the 516 Patent, its continuation patent (US8,878,053), and all “continuations and continuations-in-part of any of the foregoing.” EX1031, 7, 13. Included in the “Schedule A” listing of assigned patents was the 035 Application, one of two earlier PTAB proceedings. EX1031, 13 (Schedule A, page 7). Thus, as assignee and succeeding owner, Maxeon is in privity with SunPower and is bound by the PTAB prior decisions.

SunPower and Maxeon had a full and fair opportunity to litigate the obviousness issue and in fact had done it twice. SunPower/Maxeon presented arguments for why the specific references now relied by CSI would not have rendered obvious a solar cell with a backside oxide layer in between the substrate and a polysilicon emitter that forms a backside junction with the substrate. EX1005, 227-234, 267-270. The PTAB rejected those arguments and should now collaterally estop Maxeon from relitigating the obviousness issue again.

Finally, like in an IPR, Maxeon had the “full and fair opportunity” to submit under 37 C.F.R. §§1.131 and 1.132 relevant evidence including expert affidavits during prosecution of the 771 and 035 Applications to rebut the examiner’s rejections, which the Board could have considered on appeal. Under 37 C.F.R. §41.47, oral hearing was also available to Maxeon on appeal to the PTAB. Hence, Maxeon was not deprived of any procedural opportunities to present its case.

VIII. CLAIMS 9-11 ARE UNPATENTABLE OVER MEIER, OKAYASU, BORDEN, AND JORDAN

The combination of Meier (US6,262,359) in view of Okayasu (JP07-106611), Borden (WO2009/094578) and Jordan (US2005/0268963) would have rendered Claims 9-11 obvious.

A. Prior Art Status

- Meier (EX1011) issued on July 17, 2001 and is prior art under 35 U.S.C. §102(b).³
- Okayasu (EX1012-1013) published on April 21, 1995 and is prior art under 35 U.S.C. §102(b).
- Jordan (EX11015) published on December 8, 2005 and is prior art under 35 U.S.C. §102(b).
- Borden (EX1009) was filed January 23, 2009 and published July 30, 2009 in English. It claims priority to U.S. Provisional Patent Application No. 61/023,342 (EX1010) (“Borden Provisional”), filed January 24, 2008, about a month before the 516 Patent’s filing date. Borden is prior art under 35 U.S.C. §102(e) because the Borden Provisional supports (1) a claim of Borden and (2) the disclosures of

³ Each citation in this Petition to 35 U.S.C. §102 refers to the pre-AIA version of that statute.

Borden relied on here. *Dynamic Drinkware, LLC v. Nat’l Graphics, Inc.*, 800 F.3d 1375, 1380-82 (Fed. Cir. 2015). As shown below, the Borden Provisional supports a claim of Borden. EX1003, ¶76.

Borden EX1009 Claim 1	Borden Provisional EX1010
1. A solar cell comprising:	¶1, claim 1 (“A solar cell ...”)
an amorphous semiconductor layer formed over a substrate;	¶¶14-16, claim 1 (“A solar cell including a passivation structure consisting of a tunnel dielectric interposed between a substrate and a layer of an amorphous semiconductor”), Figs. 1-3 (EX1003, ¶76)
a dielectric layer interposed between the substrate and the amorphous semiconductor layer, wherein the dielectric layer is sufficiently thin so as to support a tunneling current therethrough.	¶14 (“The dielectric layer should be thin, on the order of 8-10Å, in order to support a tunneling current.”), claim 1 (“a tunnel dielectric interposed between a substrate and a layer of an amorphous semiconductor”), Figs. 1-3

The Borden Provisional also supports each disclosure of Borden cited in this Petition. EX1003, ¶¶77.

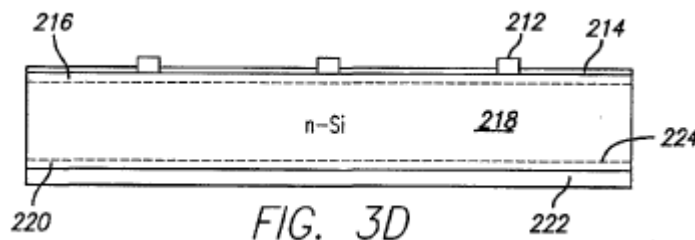
Borden EX1009 Citation in Petition	Borden Provisional EX1010 Disclosure
Abstract	Abstract
¶8	¶6
¶16	¶13

¶24	¶16
Figure 1A	Figure 1

B. The Combination of Meier, Okayasu, Borden, and Jordan

Meier disclosed a “Back Junction Solar Cell” having a substrate (218).

EX1011, Title and FIG. 3D. A “p+ [emitter] layer 220 [] forms a backside junction with the n-Si base layer 218.” EX1005, 316 (771 Appeal Brief); EX1011, 6:51-55; EX1003, ¶78. Meier also disclosed coating the front surface with an anti-reflective layer 214 and the front and back metal contacts 212 and 222, as shown in FIG. 3D. EX1011 at 6:20-54, 7:10-35.



During the 516 Patent prosecution, the only elements that the Examiner found lacking in the prior art were (1) an oxide layer in between the emitter and the substrate and (2) that the emitter was polysilicon. However, Okayasu disclosed replacing in-substrate emitters with deposited polysilicon emitters, and Borden disclosed adding a tunnel oxide layer in between. EX1003, ¶¶80-82, 84; EX1012, ¶44, Fig. 1; EX1009, ¶16. Jordan supplied the element of a textured front surface of the solar cell, which the Examiner used to combine with Meier, and was well-

known in the solar cell art for reducing reflection. EX1003, ¶83; EX1015, ¶¶ 7, 22; EX1019 (Luque), 269.⁴

Thus, it was obvious to a Skilled Artisan to modify Meier's back emitter, back junction solar cell by (1) replacing the p-type diffused in-substrate emitter with a deposited p-type *polysilicon* emitter as taught by Okayasu; (2) placing an interfacial oxide layer between the emitter and the substrate, as taught by Borden; and (3) texturing the front substrate as taught by Jordan, thereby rendering claims 9-11 unpatentable. EX1003, ¶85.

1. Modifying Meier with Polysilicon Emitter and Oxide Layer

Specifically, in the 771 Application appeal proceeding, the PTAB affirmed the Examiner's finding "that Okayasu discloses an alternative method for forming a doped emitter or a surface field on a doped substrate." EX1005, 512. The PTAB also affirmed the Examiner's motivation finding "that Okayasu teaches that its method of depositing doped polysilicon layers is preferable to that of thermal diffusion (as taught in Meier) because it can be performed at lower temperatures, preventing damage to the substrate, and allows more accurate control of the emitter thickness." *Id.*; *see also* EX1005 at 479-81. Moreover, the PTAB affirmed the

⁴ EX1019 is an authentic copy of Luque, which was publicly available by August 7, 2003 and was in any event publicly available before February 20, 2007, and thus is prior art pursuant to §§102(a)-(b). EX1024, ¶¶6, 59-65.

Examiner's finding that although "Meier as modified by Okayasu does not disclose a tunneling dielectric oxide between the emitter/front surface field and the substrate," "Borden discloses that tunnel oxides can be used in solar cells between doped polysilicon and monocrystalline substrates on both front and back surfaces of the monocrystalline substrate." *Id.* at 513. The PTAB rejected SunPower's argument that the "combined references fail to teach a backside junction emitter with a tunnel dielectric" and arguments against the combination. EX1005, 515-518. And the PTAB affirmed the Examiner's conclusion that "it would have been obvious to the skilled artisan to modify the interface between polycrystalline layers and a monocrystalline substrate front and back surface by having a tunneling oxide at the interfaces for the benefits expressed by Borden." *Id.* The Examiner found that Borden disclosed that "by providing the tunneling layer it prevents epitaxial growth of the emitter layer and further it protects the surface from plasma damage of the deposited emitter layer [0015]." EX1005, 449.

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.

2. Modifying Meier with Textured Front Surface

As the Examiner found during the 516 Patent examination and the 035 Application proceeding, the Skilled Artisan would have been motivated to modify

Meier's solar cell with a textured front surface in view of Jordan, because texturing increases light absorption and thus solar cell efficiency. EX1018, 76; EX1002, 77. The Board should come to that same conclusion here for the same reason. Further, as Dr. Banerjee explains, texturing the front surface of the solar cell to increase light absorption and solar cell efficiency was well known and well practiced in the industry before the 516 Patent. EX1003, ¶¶83, 96. Thus, there is nothing non-obvious about texturing the front surface of the solar cell.

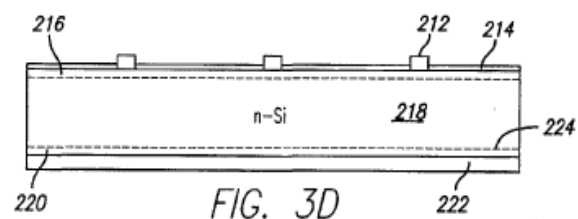
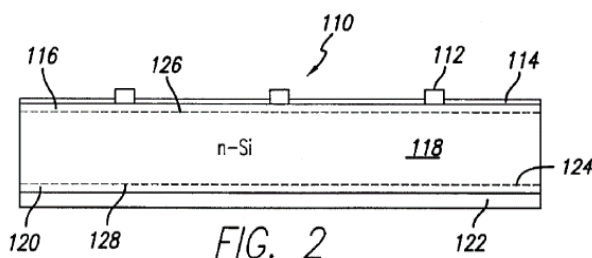
C. Meier, Okayasu, Borden, and Jordan Disclosed All Elements

1. Preamble

All the references relied here disclosed “*a solar cell having a front side facing the sun to collect solar radiation during normal operation and a backside opposite the front side,*” as recited in challenged Claim 1. EX1003, ¶100.

Referring to FIG. 2, Meier disclosed a “[s]olar cell layer stack 110 includes a base layer 118 of n-type conductivity, which is defined by an *illuminated surface (front or top surface)* 126 and a *non-illuminated surface (back or bottom surface)* 128.”

EX1011 at 4:35-39. FIG. 2 shows the identical structure as FIG. 3D, except for its numerical labels. EX1003, ¶100.



2. [9a] Substrate with a textured front surface

Challenged Claim 9 requires “*a substrate having a textured front surface.*”

Claim 21 of the rejected 035 Application similarly recited “a N-type silicon substrate having a front surface and a back surface, wherein the front surface comprises a textured surface.”

All relied upon references disclosed solar cells having “a substrate,” EX1003, ¶105. In Meier, the substrate is the “n-Si base layer 118” or “218” in FIGS. 2 and 3D. EX1011, 4:27-52, 5:31-49; *see also*, EX1015 (Jordan), ¶44 and FIG. 1 (boron, P-doped, multicrystalline wafer 10); EX1009 (Borden), ¶16 (“substrate”); EX1012 (Okayasu), ¶44, Fig. 1 (substrate 1).

Although Meier did not disclose that its substrate had a “textured front surface,” texturing the front surface of the substrate was a well-known technique in the solar cell industry to reduce light reflection and increase light absorption of the solar cell. EX1003, ¶106. As explained in Jordan, “[t]exturing generally increases the efficiency of the resulting photovoltaic cell by increasing light absorption.” EX1015, ¶22. Thus, Jordan disclosed that in fabricating a solar cell, “the front surface of the wafer [*i.e.*, substrate] is preferably textured.” *Id.* So did Borden’s FIG. 1A. EX1009, 12.

During prosecution, the 516 Patent Examiner correctly found, and Maxeon’s predecessor did not dispute, that “it would have been obvious to one of ordinary

skill in the art at the time of the invention to modify the front surface of Meier by texturing the front surface as disclosed by Jordan because it increases light adsorption.” EX1002 at 77; EX1003, ¶97. In the 035 Application proceeding, the Examiner again found, and Maxeon did not dispute, this same combination of Meier and Jordan and a motivation to modify Meier’s substrate to include a textured front surface. EX1018, 247-48.

3. [9b] Back Surface Emitter

Challenged Claim 9 requires “*an emitter layer formed over a back surface of the substrate, the emitter layer forming a backside junction with the substrate.*”

Claim 1 of the rejected 771 Application similarly recited “an emitter disposed over the tunnel dielectric [which is disposed over the back surface of the substrate], the emitter forming a backside junction with the substrate.”

As Maxeon’s predecessor, SunPower, admitted in its Appeal Brief in the 771 Application proceeding, “Meier disclosed forming a p⁺ layer 220 that forms a backside junction with the n-Si base layer 218.” EX1005, 460; EX1003, ¶108. The p⁺ layer 220 in FIG. 3D or 120 in FIG. 2 of Meier is a “p⁺ emitter layer.” EX1011 at 4:50-52, 55; EX1003, ¶108. It is formed “by diffusion into the substrate.” EX1005, 460-61.

Challenged Claim 11 additionally requires that the “the emitter layer” to be polysilicon. Meier did not teach a polysilicon emitter layer. However, as the 771

Application Examiner correctly found and the PTAB affirmed, Okayasu (which was not considered during the 516 Patent prosecution) taught “an alternative method for forming a doped emitter or a surface field on a doped substrate” and that “its method of depositing doped polysilicon layers is preferable to that of thermal diffusion (as taught in Meier) because it can be performed at lower temperatures, preventing damage to the substrate, and allows more accurate control of the emitter thickness.” EX1005, 512; EX1012, ¶¶8, 14, 43; see also, EX1003, ¶109. The advantage of a polysilicon emitter over a diffused emitter would have motivated the Skilled Artisan to replace Meier’s diffused backside emitter with a backside polysilicon emitter. EX1003, ¶¶86-95, 128.

In the 771 Application proceeding, SunPower “contend[ed] that the proposed modification uses Okayasu’s teaching of forming a BSF layer on the solar cell backside for a totally different function (forming a backside junction) in Meier.” EX1005, 516. However, the PTAB correctly rejected SunPower’s arguments as missing the point of the Examiner’s combination, explaining that “[t]he Examiner employs Okayasu for its teaching of depositing a doped polysilicon layer on a doped substrate. *See* [EX1005, 487]. The rejection is not based on a finding that the BSF (as opposed to the doped polysilicon layer) can be substituted for Meier’s p-type emitter.” EX1005, 516-17.

The Board further reasoned and correctly concluded:

Okayasu discloses that the prior art plasma CVD method has advantages, but introduces floating foreign substances that are mixed in the n+ silicon layer of p+ silicon layer. Okayasu ¶ 9. However, Okayasu addresses preventing generation of floating foreign substances in the inventive process. *Id.* ¶16. “[T]he prior art must be considered *as a whole* for what it teaches.” *Medichem, S.A. v. Rolabo, S.L.*, 437 F.3d 1157, 1166 (Fed. Cir. 2006). Okayasu would have given the skilled artisan adequate motivation to combine its teaching with that of Meier in disclosing the problems associated with the thermal diffusion method. *Id.* ¶¶6-8.

EX1005, 516-17.

Neither SunPower nor Maxeon disputed the Examiner’s identical finding in the later 035 Application on appeal, effectively conceding that the PTAB was correct in affirming the Examiner’s findings on the earlier 771 Application appeal. EX1018, 227-270 (035 Application appeal briefing).

The modified solar cell of Meier (as modified to have a backside polysilicon emitter as taught by Okayasu and a textured front surface as taught by Jordan) forms the basis for the discussion of the next element.

4. [9c] Oxide layer

Challenged Claim 9 requires “*an oxide layer formed between the back surface of the substrate and the emitter layer.*” Although the rejected 771 Application claims used slightly different words, they claimed the same arrangement, by reciting “a tunnel oxide disposed over the back surface of the

substrate” and “an emitter disposed over the tunnel dielectric,” wherein “the tunnel dielectric is a tunnel oxide.”

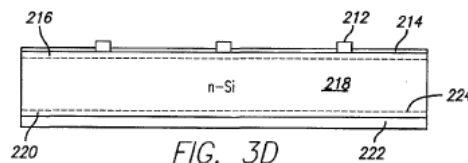
The 771 Application Examiner found, and the PTAB correctly affirmed, that although “Meier as modified by Okayasu does not disclose a tunneling dielectric oxide between the emitter/front surface field and the substrate,” “Borden discloses that tunnel oxides can be used in solar cells between doped polysilicon and monocrystalline substrates on both front and back surfaces of the monocrystalline substrate.” EX1005 at 513. And the PTAB affirmed the Examiner’s conclusion that “it would have been obvious to the skilled artisan to modify the interface between polycrystalline layers and a monocrystalline substrate front and back surface by having a tunneling oxide at the interfaces for the benefits expressed by Borden.” *Id.*

The PTAB’s finding was correct in the 771 Application, and it should again make this finding here. EX1003, ¶¶112. Maxeon disputed this in the 771 Application and lost; when it had another opportunity to dispute this finding in the subsequent 035 Application, where the Examiner made the same finding (EX1018, 246-49), Maxeon no longer disputed it in the 035 Application, and therefore effectively conceded this point (EX1018, 227-234, 267-270).

5. [9d] - [9e] First and second metal contacts

Challenged Claim 9 recites: “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.” In the modified solar cell of Meier, Okayasu, Borden and Jordan, in which Meier’s p+ layer emitter 220 is replaced by a polysilicon emitter layer from Okayasu as discussed above, the aluminum metal contacts 222 would still electrically contact the emitter layer on the backside, as the Examiner found in the 771 Application and 035 Application. EX1003, ¶115.

Specifically, Meier disclosed front and back metal contacts 212 and 222, as seen from FIG. 3D. The front metal contacts 212 contain silver (EX1011, 7:26-28). They are in contact with the substrate on the front because, as Meier disclosed, the “silver layer is fired through the [anti-reflective] coating” 214. *Id.*, 6:51-54; EX1003, ¶116 (citing EX1019 at 275). The back metal contacts 222 contain aluminum. EX1011, 7:26-28. When the diffused back emitter layer 220 in Meier is replaced with a polysilicon emitter, as taught by Okayasu, the metal contacts 222 would still be electrically connected to the polysilicon emitter.



EX1003, ¶¶115-116.

Notably, Okayasu also taught front metal contacts made up of silver and back metal contacts made up of aluminum contacting the polysilicon layer.

EX1012, ¶44; EX1003, ¶115.

6. [9f] Configured to power external circuit

Challenged Claim 9 recites: “*the first metal contact and the second metal contact being configured to allow an external electrical circuit to be powered by the solar cell.*” This element is met by any solar cell because powering an external electrical circuit is the objective any solar cell. EX1003, ¶118. As Meier explained, “[s]olar cells are widely used because they convert easily accessible energy from a light source, such as the sun, to electrical power to operate electrically driven devices, e.g., calculators, computers, and heaters used in homes.” EX1011, 1:15-18. “Calculators, computers and heaters” are all external electrical circuits when connected to the solar cell. EX1003, ¶118. The ‘516 Patent’s “Description of the Background Art” admits that “[s]olar cells are well known devices for converting solar radiation to electrical energy” and “[t]he metal contacts allow an external electrical circuit to be coupled to and be powered by the solar cell.” EX1001, 1:19-30.

Thus, all elements of Claim 9 are found in the combination of Meier, Okayasu, Borden, and Jordan.

7. Claim 10 – Anti-reflective layer

Challenged Claim 10 depends from Claim 9, and recites “*an antireflective layer over the textured front surface of the substrate.*” Claim 21 of the rejected 035 Application similarly requires “an antireflective layer over the front surface of the N-type silicon substrate.” The modified solar cell of Meier, Okayasu, Borden, and Jordan would meet the limitation of an antireflective layer being formed over the textured front surface.

Meier disclosed “an anti-reflecting coating 214” that is deposited on the substrate’s front surface. EX1011, 6:20-21, FIG. 3D. Jordan, which disclosed texturing the front surface (EX1015, ¶22), likewise disclosed that after texturing, “a surface coating, preferably one that can function as an anti-reflective coating, is deposited on the front surface of the wafer” (EX1015, ¶24). Because the anti-reflective coating is deposited after texturing, the anti-reflective layer would be “over” the substrate’s textured front surface. EX1003, ¶122.

8. Claim 11 – N-type substrate and P-type emitter

Challenged Claim 11, depends from Claim 9, and recites “*the substrate comprises an N-type silicon substrate and the emitter layer comprises a P-type doped polysilicon.*” Claims 21 and 23 of the rejected 035 Application similarly recite “a N-type silicon substrate” and that the “polysilicon emitter comprises a P-

type doped polysilicon.” The opposite polarity of the polysilicon layer and the substrate forms a “backside junction,” as recited in claim 9.

In the 035 Application, the PTAB correctly affirmed the Examiner’s finding that the combination of Meier and Okayasu discloses these limitations. To improve on the conventional front junction solar cell, Meier taught a backside junction solar cell with an N-type silicon substrate and a backside P-type emitter. EX1011, 4:27-58. Okayasu taught the advantages of replacing a diffused emitter with a polysilicon emitter, and it would have been obvious to a Skilled Artisan to replace the P-type in-substrate emitter of Meier with a P-type polysilicon emitter (EX1003, ¶124), as the Examiner in the 035 Application found and affirmed by the Board. EX1018, 246-49, 286-293.

The PTAB had already rejected SunPower’s arguments against the combination of Meier and Okayasu in the 771 Application appeal proceeding, and should do the same again. EX1005, 507-520; EX1018, 286-293.

IX. CLAIMS 9-11 ARE UNPATENTABLE OVER MEIER, OKAYASU, FOGLIETTI, GAN, AND JORDAN

The combination of Meier, Okayasu, Foglietti, Gan and Jordan would have rendered Claims 9-11 obvious. The reasons for combining Meier, Okayasu, and Jordan are the same as discussed in the prior ground, and this combination satisfies all the elements of Claims 9-11 except for the “oxide layer” in between the polysilicon emitter and the substrate. *See* §§VIII.B, VIII.C.1-VIII.C.3, and

VIII.C.5-VIII.C.8 above. The only difference between this ground and the prior ground is that Foglietti and Gan are used for the teaching of the oxide layer instead of Borden.

A. Foglietti (EX1014)

U.S. Patent Pub. No. 2002/0142500 (“Foglietti”) (EX1014) was published October 3, 2002. EX1009, face. It is prior art under 35 U.S.C. §102(b).

Foglietti taught the benefits of forming an interfacial oxide with a polysilicon emitter. EX1003, ¶126. Foglietti disclosed: “This thin oxide layer can affect substantially the operation of the transistor and impact its current gain....

The interfacial oxide tends to have a beneficial impact on the gain of the bipolar transistor.” EX1014, ¶¶2-3. Foglietti disclosed that an interfacial oxide with good integrity prevents the polysilicon emitter grains from realigning. “Consequently, none of the polysilicon grains assume the orientation of the underlying substrate 250, that is, no grain realignment is observed in the polysilicon 262.

Consequently, hole current therewith is minimized and the transistor gain is increased. Additionally, due to good interfacial oxide uniformity, the transistor gain is substantially repeatable from wafer to wafer.” EX1014, ¶¶28,46. This is also known as epitaxial realignment. EX1014, ¶¶8-9.

B. Gan (EX1007)

Gan et al., “Polysilicon Emitters for Silicon Concentrator Solar cells,” Proceedings of the 21st IEEE-PVSC (“Gan”) was a paper presented in 1990 (EX1007, face, ii-iii) and the paper was published by at least 1994 and no later than August 6, 2002 when it was publicly available electronically for download from *IEEE Xplore*, and in any event was publicly available before February 20, 2007. EX1024, ¶¶6, 29, 66-72; EX1046. Gan was widely distributed and has been known and cited by others in the field at least by 1994, further confirming its public dissemination before February 20, 2007. EX1024, ¶72; EX1047; EX1048. EX1007 is an authentic copy of Gan that was published before February 20, 2007. EX1024, ¶¶6, 66-72. Thus, it is prior art under 35 U.S.C. §102(a) and (b).

Gan examined “polysilicon emitters with a thermally grown interfacial oxide” for solar cells in “great detail.” EX1007, 245. Gan disclosed that “a very thin oxide (interfacial oxide)” “always exists” between the polysilicon emitter and substrate, “which can be as a by-product of the cleaning process or is grown intentionally.” EX1007, 245. Gan found that solar “cell performance can be improved if the diffused-emitter [*i.e.*, an emitter doped into the substrate, as in Meier] is replaced with the polysilicon emitter, ...” EX1007, 245; EX1003, ¶128. Gan experimented with thin interfacial oxides typically less than 20 Angstroms.

EX1007, 246. Gan also tested both N- and P-type emitters. EX1007, Figs. 4-5, 249.

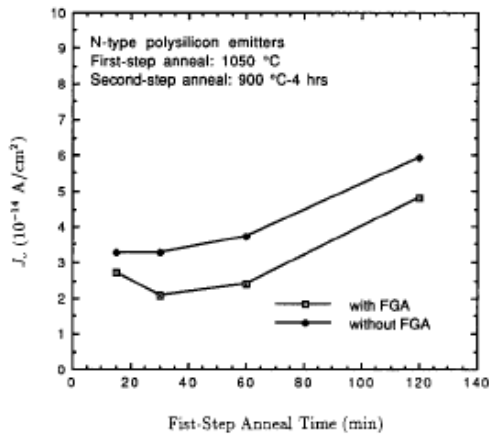


Figure 4: The J_0 versus the first-step anneal time for n-type polysilicon emitters.

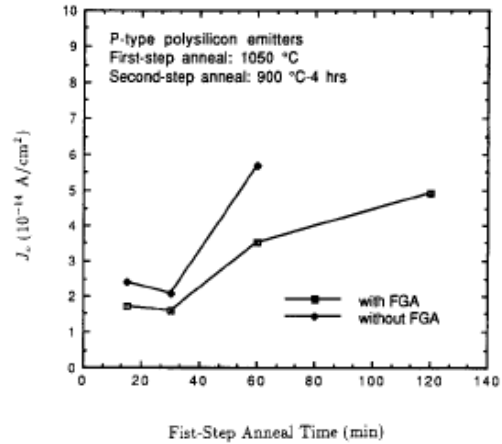


Figure 5: The J_0 versus the first-step anneal time for p-type polysilicon emitters.

Gan observed better J_0 results with the “use of thermal oxide as the interfacial layer in our samples.” EX1007, 248; EX1003, ¶128. Gan concluded that “polysilicon emitters with low J_0 and ρ_c can be obtained with a very small fraction of interfacial oxide breakup.”⁵ EX1007, 249. Gan taught that “polysilicon emitters with these qualities can be quite useful for silicon concentrator solar cells.” EX1007, 249. Gan further noted that “more than one absolute percent of the cell efficiency is obtained for backside contact solar cell

⁵ J_0 measures reverse saturation current density, and ρ_c measures the resistivity of the contact. EX1003, ¶129. A lower J_0 number indicates a lower recombination that tends to improve solar cell performance. *Id.* A lower ρ_c indicates lower contact resistance, and leads to higher efficiency. *Id.*

with polysilicon emitters with characteristics shown here ...” *Id.* Backside contact solar cells were known to have their PN junction on the solar cells’ backside.

EX1003, ¶129.

C. Combination of the Modified Meier with Foglietti and Gan

Both Foglietti and Gan, like Borden, taught the benefits of having an oxide layer in between the polysilicon emitter and the substrate, and Gan specifically taught the benefits in the solar cell context. EX1003, ¶¶131-132. This would have motivated the Skilled Artisan to combine an oxide layer with the solar cell of Meier, as modified by Okayasu and Jordan. EX1003, ¶134. In the 771 Application appeal proceeding, the PTAB affirmed the Examiner’s obviousness rejection based on combining the modified Meier with Fogliett and Gan:

The Examiner finds that Foglietti discloses that polycrystalline growth directly on crystalline silicon results in partial realignment of the polycrystalline grains and this effect can be suppressed by growth of a thin oxide. Final Act. 7 (citing Foglietti ¶ 46). The Examiner finds that Gan teaches that he presence of a stable thermal oxide between a polysilicon emitter and a CZ layer. *Id.* The Examiner concludes that it would have been obvious to one of ordinary skill in the art to modify the interface between the doped polysilicon regions and the monocrystalline substrate by adding an interfacial oxide as disclosed by Foglietti and Gan to allow for optimal growth of the

polysilicon region and result in recombination occurring primarily at the oxide interface. *Id.*

Appellant's arguments against combining Foglietti or Gan with the modified Meier is substantially the same as that made in opposing Rejection I. Compare App. Br. 10-11 with App. Br. 6-7.

For the reasons provided *supra* relating to Rejection 1, we do not find Appellant's arguments persuasive to show reversible error, and sustain Rejection 2.

EX1005, 519. The PTAB prior findings and conclusions were correct, and it should rule the same in this IPR. EX1003, ¶¶131-135.

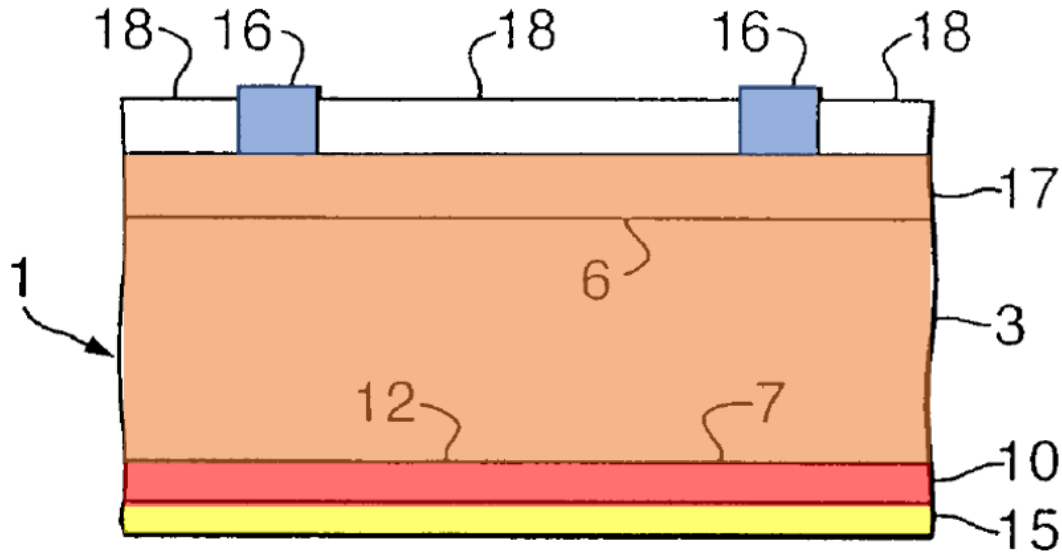
X. FROITZHEIM AND GAN WOULD HAVE RENDERED CLAIMS 9-12 OBVIOUS

A. EP1732142A1, Froitzheim (EX1006)

EP1732142A1 ("Froitzheim") was published on December 13, 2006.

EX1006, face. It is prior art under 35 U.S.C. §102(b). This reference was not considered during 516 Patent's prosecution.

Froitzheim explained that in conventional solar cells, the emitter is placed at the front of the cell to form a PN junction with an oppositely doped P-type substrate. EX1006, ¶2; EX1003, ¶137. However, just like in Meier relied on by the Examiner and PTAB, Froitzheim proposed to instead place the emitter/PN junction at the solar cell's backside. EX1006, ¶¶8, 11. Froitzheim's Figure 1, shown below, is a solar cell 1 having an N-type body layer or substrate 3 with a front side 6 and a rear side 7. EX1006, ¶24.

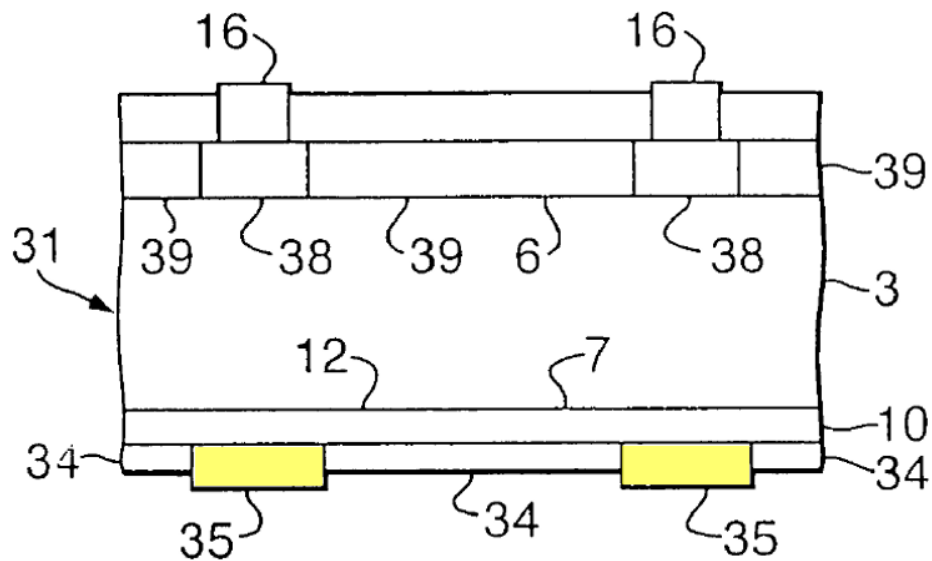


Starting from the bottom, a “rear side contact 15 [yellow] is arranged in electrical connection with the p-doped layer 10 [red],” which is an emitter.

EX1006, ¶¶25-27. This backside P-doped emitter is formed by diffusing boron (a P-type dopant) into the N-type substrate. EX1006, ¶¶24, 26, 40-41; EX1003, ¶138. The P-doped emitter 10 (red) forms a PN junction 12 with the N-type silicon body layer 3 [(orange). EX1006, ¶¶24-25. Unlike Meier, Froitzheim additionally disclosed that “etching can be used to texture the surface in order to improve the geometry of incidence of light in order to prevent reflection” at the front side. EX1006, ¶¶39, 56; EX1003, ¶139. An optional n+ front surface field 17 [orange] is depicted on substrate 3, EX1006, ¶¶15-17, 28, 59. The front side n+ surface can be made by diffusion of phosphorous to the substrate, and thus the n+ layer is part of the substrate. EX1006, ¶¶43-44; EX1003, ¶140. Finally, “at the front side 6,

screen-printed front side contacts 16 [blue] are provided in electrical connection with the n-type silicon body layer.” EX1006, ¶28.

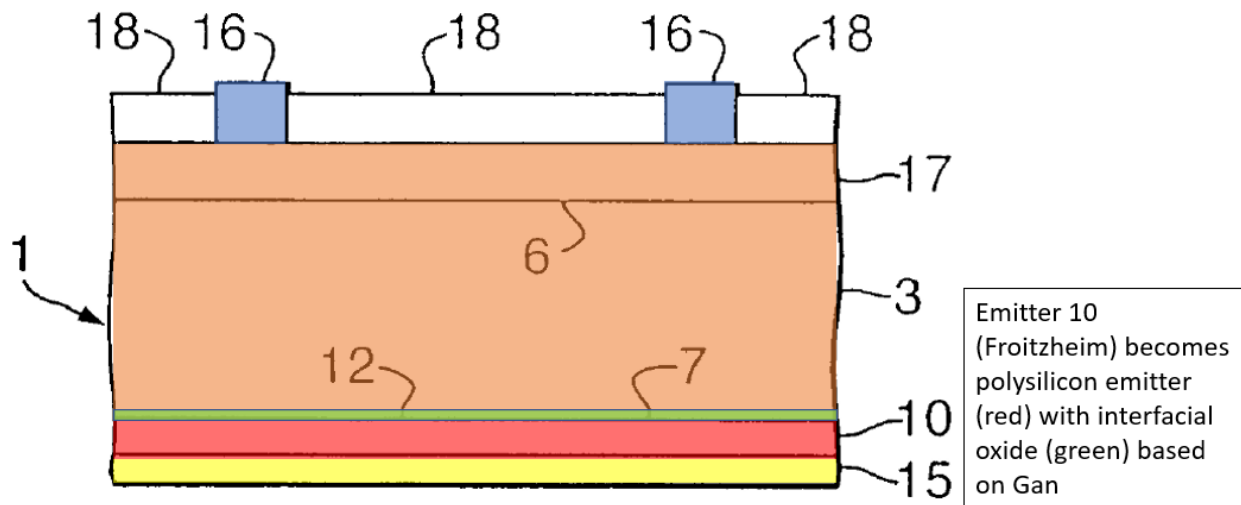
Froitzheim disclosed an alternate configuration for the rear contacts 15 that do not cover the entire backside so that “less material such as Ag [silver] or Al [aluminum] is required for the contacts.” EX1006, ¶¶20, 33. Figures 3-5 depict this configuration, and Figure 3 is reproduced below showing the alternative rear contacts 35 (yellow):



Similar to FIG. 1, layer 10 is the p-type emitter region formed on an N-type substrate 3, which forms a backside junction. An additional “passivation layer 34” made of silicon oxide is also formed on the p-type emitter region 10 and the metal contacts 35 formed over the passivation layer 34. EX1006, ¶¶19, 30, 33, 50; EX1003, ¶142.

B. Combination of Froitzheim and Gan

The Froitzheim/Gan combination is straightforward. Froitzheim's back junction solar cell would be modified so that Froitzheim's p-type (boron) *diffused* emitter is replaced with a p-type *polysilicon* emitter that also includes an interfacial oxide layer between the emitter and the substrate, as taught by Gan. A modified Froitzheim Fig. 1 illustrated below. EX1003, ¶143.



1. Motivation to Modify Froitzheim with Gan

Froitzheim and Gan are analogous art because each is in the same field of endeavor—solar cell design. EX1001, 1:15-17; EX1003, ¶144; EX1006, Abstract, ¶¶1,9; EX1007, 245, 249. Each is also reasonably pertinent to the problems of efficiency and cost-effectiveness of solar cell designs. EX1001, 1:40-42; EX1003, ¶144; EX1006, Abstract, ¶¶1,9; EX1007, 245, 249.

The Skilled Artisan would have been motivated to replace Froitzheim's diffused emitter with a polysilicon emitter along with an oxide layer because Gan

taught and suggested that this modification would improve the solar cell. EX1003, ¶145. Gan disclosed that “*the cell performance can be improved if the diffused-emitter [of Froitzheim] is replaced with the polysilicon emitter,....*” EX1007, 245 (emphasis added). Gan also noted that “the J_0 [i.e., indication of surface recombination] of the p-type polysilicon emitter (Fig 5) [beneficially] appears to be much lower than what has been previously reported,” and suggested that it “may have to do with the use of thermal oxide as the interfacial layer in our samples.” EX1007, 248. Gan explained that “because the dominant recombination is likely at the oxide interface, it implies that the oxide must only be broken by a very small fraction, which is consistent with what was observed in Fig. 2.” EX1007, 248.

Gan went on to provide lowered J_0 and ρ_c data in Figure 6 and concluded the characteristics brought about by the polysilicon emitter with interfacial oxide layer structure is “*quite useful for silicon solar cells.*” EX1007, 249 (emphasis added). Froitzheim likewise used silicon solar cells. EX1006, Abstract. Gan further pointed to prior modeling and determined that “more than one absolute percent of the cell efficiency is obtained for a backside contact solar cell with polysilicon emitters with characteristics shown here” EX1007, 249. It is noteworthy that Gan’s calculations are in the context of a backside contact solar cell which, like Froitzheim, would place the emitter and PN junction on the

backside of the solar cell, which would further suggest the combination. EX1003, ¶146.

While Gan referred in part to silicon concentrator solar cells, it also more broadly suggested that a polysilicon emitter with interfacial oxide is “quite useful for silicon solar cells” generally (EX1007, 249), and the Skilled Artisan would interpret Gan as recommending the feature for solar cells in general. EX1003, ¶147. Gan also disclosed that the benefits apply to both N- and P-type polysilicon emitters, including those formed on the back side of the solar cell, and thus would have suggested replacing Froitzheim’s rear p-type diffused *silicon* emitter with a rear p-type *polysilicon* emitter plus the beneficial interfacial oxide layer. EX1007, 249; EX1003, ¶147.

The Skilled Artisan would further have been motivated specifically to leave the emitter on the solar cell’s back side because Froitzheim disclosed that the back junction design “shows improved stability and good efficiency.” EX1006, ¶9. As Dr. Banerjee explains, it was well known that back junction solar cells often lead to higher solar cell efficiency than front junction cells. EX1003, ¶148. In the combination, Froitzheim’s modified emitter would continue to function as before, but with the expected additional improvement provided by the polysilicon emitter and interfacial oxide layer. EX1003, ¶148. And replacing the diffused emitter with the polysilicon emitter and the interfacial oxide layer, as taught by Gan,

merely substitutes one element for another already known in the field, yielding a predictable result. EX1003, ¶148; *KSR Int’l Co. v. Teleflex Inc.*, 550 U.S. 398, 416 (2007).

Aside from Gan, numerous other prior art references taught the inclusion of an interfacial oxide layer when replacing a diffused emitter with a polysilicon emitter. For example, as discussed in §IX.C, the 771 Application Examiner found that Foglietti taught the beneficial formation of an interfacial oxide with a polysilicon emitter as it suppresses the “partial realignment of the polycrystalline grains.”⁶ EX1003, ¶149 (citing EX1014, ¶¶2-3). Foglietti further disclosed other benefits of the interfacial oxide including “hole current therewith is minimized and the transistor gain is increased” and “is substantially repeatable from wafer to wafer.” EX1014, ¶¶28,46. The Skilled Artisan would have thus further been motivated to include a polysilicon emitter with an interfacial oxide in Froitzheim because these benefits are equally transferable to solar cells. EX1003, ¶149

In the solar cell context, the Skilled Artisan would have further been motivated to include a polysilicon emitter with an interfacial oxide in Froitzheim

⁶ While Foglietti is directed to a bipolar transistor, the Skilled Artisan would have looked to it when designing solar cells as was commonly done in the art, as seen by the suggestion of Yablonovitch and others. EX1003, ¶¶59-60; EX1016, 597; EX1020, 363; EX1021, 497; EX1007, 245. Indeed, the use of polysilicon emitters in solar cells was an idea adapted from bipolar transistors. EX1003, ¶149.

because Kwark taught that addition of an interfacial chemically grown oxide (chemox) between polysilicon and the substrate “greatly decreases the J_{oc} ,” which “translates into potential improvements of energy conversion efficiency for solar cells.” EX1008, 742, 745; EX1003, ¶150. Kwark provided data comparing polysilicon emitters with and without the oxide layer, and noted “the large difference when the interfacial oxide is missing.” EX1008, 745 Fig. 4.

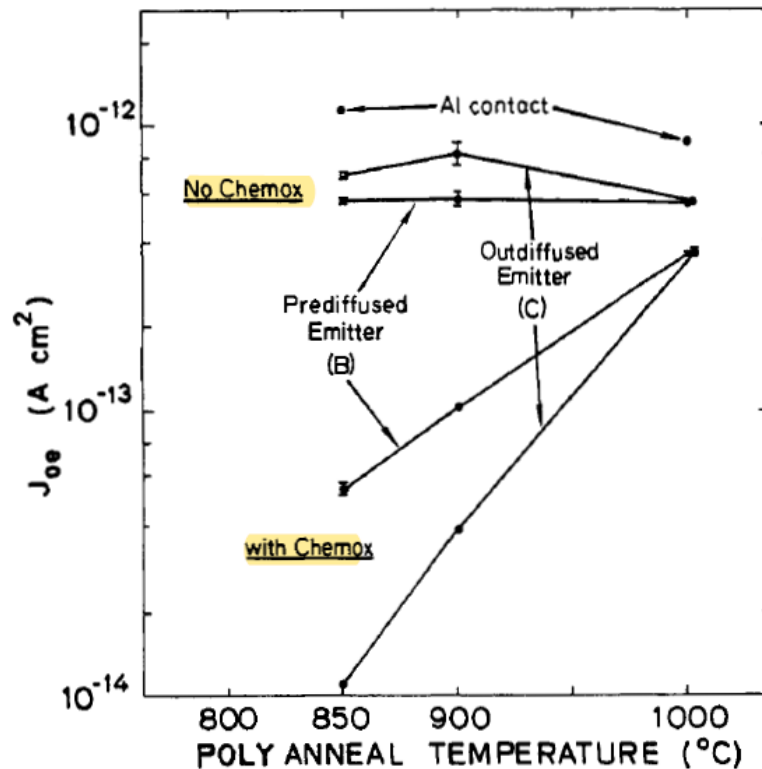


Fig. 4: emitter saturation current for POLY contacts with and without a chemically grown interfacial layer vs. anneal temperature. Thicknesses range from 3000-3600 angstroms. Note the large difference when the interfacial oxide is missing.

And as discussed in §VIII.B.1, Borden also disclosed in the context of solar cells that the tunnel oxide “prevents epitaxial growth,” allowing for “optimum

band structure” and “provides a layer to protect the surface from plasma damage.”

EX1009, Abstract. These benefits apply to both amorphous silicon and polysilicon. EX1003, ¶151.

2. Reasonable Expectation of Success

The Skilled Artisan 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). EX1003, ¶152.

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. EX1003, ¶153; EX1007, 246.

Combining Froitzheim/Gan as described here would have been well within the level of ordinary skill in the art and would not have resulted in any unpredictable results. EX1003, ¶¶154-155. It could have been readily accomplished without undue experimentation and with a reasonable expectation of

success. *Id.* Substituting Froitzheim’s in-substrate emitter with a deposited polysilicon emitter and oxide layer would be a simple substitution of prior art elements according to known methods to yield predictable results. *Id.* It would further constitute use of a known technique (depositing polysilicon emitters with an oxide layer) to improve similar devices (Froitzheim’s solar cell) that was ready for improvement in the same way. *Id.*

C. Combination of Froitzheim and Gan Disclosed All Elements

1. Claim 9

a) Preamble

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.*”

Froitzheim meets this by disclosing: “During 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.” EX1006, Figure 1, ¶32.

b) [9a] Textured substrate

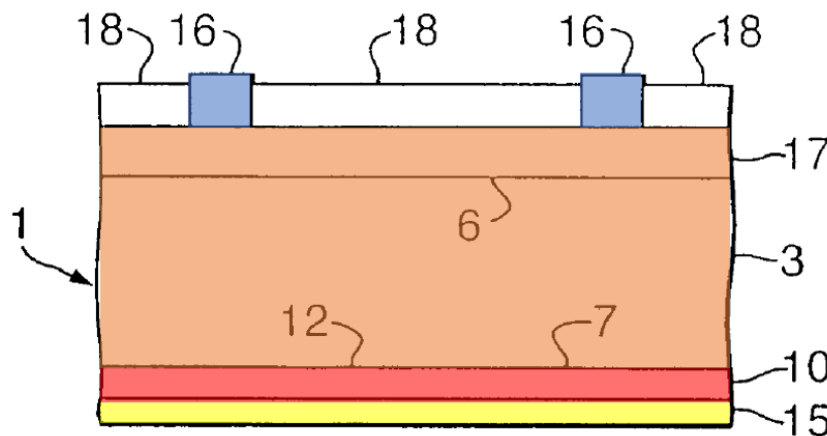
Claim 9 recites: “*a substrate having a textured front surface.*” Froitzheim meets this by disclosing, “[i]f desired a short, alkaline crystal-oriented etching can be used to texture the surface in order to improve the geometry of incidence of light in order to prevent reflection.” EX1006, ¶39. The Skilled Artisan would understand that solar cells receive incident light on the front surface. EX1003,

¶157. And texturing of the front surface prevents reflection of the light away from the cell and deflects the light into the cell body. *Id.*; EX1006, ¶39; EX1019, ¶269.

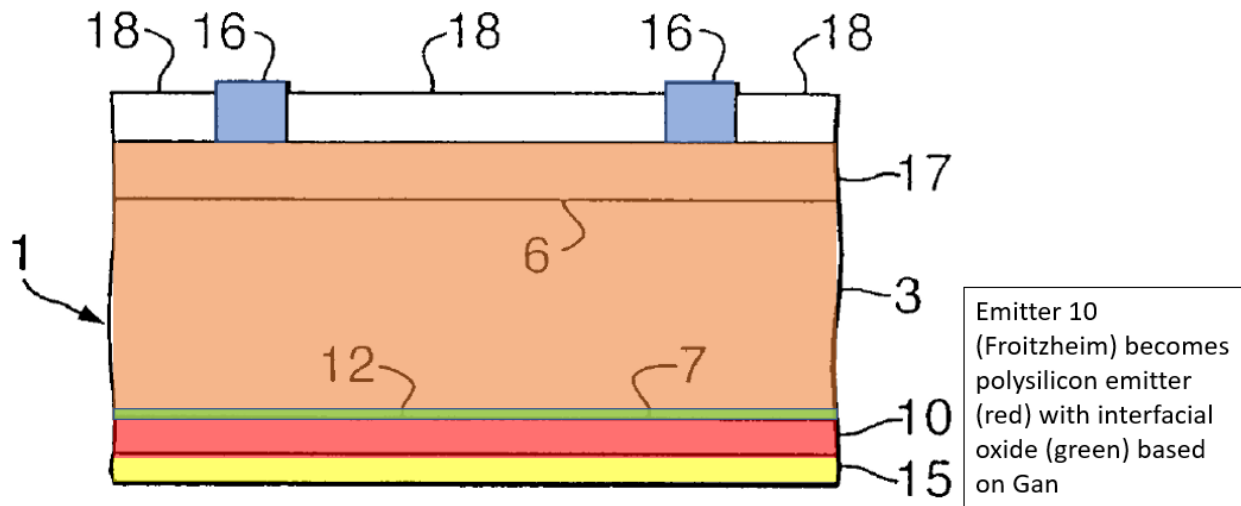
c) [9b] back surface emitter and junction

Claim 9 recites: “an emitter layer formed over a back surface of the substrate, the emitter layer forming a backside junction with the substrate.” A backside junction, as opposed to a back surface field, is formed by an emitter layer that has an opposite dopant type than the silicon substrate. EX1001, Abstract, 1:46-48; *see also* EX1005 at 300-301, 317-18, 353-55.

In Froitzheim, the p-type doped emitter 10 (red) in the figure below forms a “PN junction 12” with the n-type substrate on the backside of the solar cell, and thus forms a “backside junction.” EX1006, ¶¶24-27.



In the Froitzheim/Gan combination, Froitzheim’s p-type diffused emitter is replaced with a p-type polysilicon emitter and oxide layer as taught by Gan. This modified emitter meets the claim as it is *formed over a back surface of the*

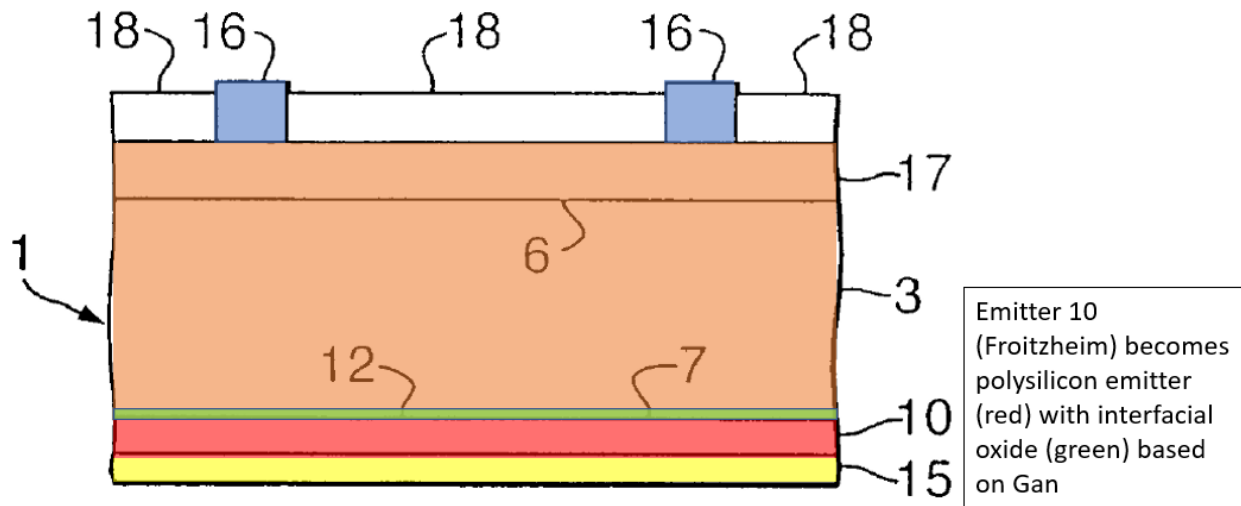


Gan disclosed that with polysilicon emitters, “there always exists a very thin oxide (interfacial oxide), which can be as a by-product of the cleaning process or is grown intentionally.” EX1007, 245. And Gan (along with several other references discussed in §X.B.1) taught that this interfacial oxide layer is beneficial. EX1003, ¶¶129, 162.

e) [9d] First metal contact and [9e] second metal contact

Claim 9 recites: “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.”

Froitzheim disclosed both front and back metal contacts, by disclosing screen-printing the front contacts 16 (blue) and back contacts 15 (yellow) in modified Figure 1 below. EX1003, ¶164; EX1006, ¶¶49,60.



The front contacts “are provided in electrical connection with the n-type silicon body layer.” EX1006, ¶28. The “rear side contact 15 is arranged in electrical connection with the p-doped [emitter] layer 10.” EX1006, ¶27. In the modified Froitzheim solar cell where the diffused in-substrate emitter is replaced with a polysilicon emitter, as taught by Gan, the rear contact 15 would make electrical connection with the polysilicon emitter. EX1003, ¶165.

As is well known, screen-printed contacts are made from silver paste, which forms metal contacts. EX1003, ¶166; EX1019, 275, 277; EX1011, 7:10-35 (silver paste for front screen printing). Froitzheim likewise disclosed that its screen printed contacts contain silver. EX1006, ¶¶49, 60. Froitzheim further taught techniques so that “less material such as Ag [silver metal] or Al [aluminum metal] is required for the contacts,” which further confirms that the contacts are metal. EX1006, ¶20. The front and back contacts in Gan are also metal. EX1007, 246.

f) [9f] Configured to power external circuit

Claim 9 recites: “*the first metal contact and the second metal contact being configured to allow an external electrical circuit to be powered by the solar cell.*”

Froitzheim disclosed: “Front and rear side contacts are arranged that are 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” and thereby power an external circuit. EX1006, ¶2; The very purpose of withdrawing electric current from the solar cell is to power an external circuit, and this was well known and inherent to the functioning of a solar cell. EX1003 ¶169; EX1011, 1:15-18; EX1001, 1:19-30. Moreover, Froitzheim disclosed hooking up the solar cell to measurement instruments to test the current output and efficiency of the solar cell, which demonstrates that the metal contacts were configured to power an external circuit. EX1003 ¶170; EX1006, ¶55.

Thus, Froitzheim/Gan disclosed all elements of claim 9 as shown above.

To the extent Maxeon might argue that the combination of Froitzheim and Gan do not sufficiently disclose this inherent claim element, it would have been obvious to incorporate this claim element in that combination. For example, Meier disclosed in its background section that “[s]olar cells are widely used because they convert easily accessible energy from a light source, such as the sun, to electrical power to operate *electrically driven devices, e.g., calculators, computers, and*

heaters used in homes.” EX1011, 1:15-18 (emphasis added). It would have been obvious to the Skilled Artisan to configure the metal contacts to power electrical devices. EX1003, ¶172.

2. Claim 10

Claim 10 depends from claim 9 and further requires “*an antireflective layer over the textured front surface of the substrate.*”

The 516 Patent discloses silicon nitride as forming an antireflective layer. EX1001, 2:50-56. Froitzheim likewise disclosed that “SiN [silicon nitride] was used in all cases as antireflection as well as surface passivation coating for n- and p-type silicon.” EX1006, ¶60. Froitzheim disclosed using silicon nitride for the *front* surface passivation, which naturally would be antireflective as well. *Id.*, ¶19, 30-31; EX1003, ¶174; EX1022, 232 (silicon nitride layers “combin[e] in one processing step an antireflection coating deposition along with surface and bulk passivation”). Froitzheim also disclosed that the anti-reflection coating is applied after the step of texturing and front dopant diffusion in the manufacturing process. *Id.*, ¶38-39, 50. Thus, a Skilled Artisan would understand that Froitzheim’s antireflective layer would be formed over the *textured front surface* of the substrate because it is applied after texturing. EX1003, ¶¶174; EX1019, 272, Fig. 7.6; EX1022, 239. Because the Froitzheim/Gan combination merely replaces the diffused emitter in Froitzheim with a polysilicon emitter with interfacial oxide

layer, as taught by Gan, the combination meets this element in claim 10. EX1003, ¶175.

3. Claim 11

Claim 11 depends from claim 9 and recites: “*wherein the substrate comprises an N-type silicon substrate and the emitter layer comprises a P-type doped polysilicon.*”

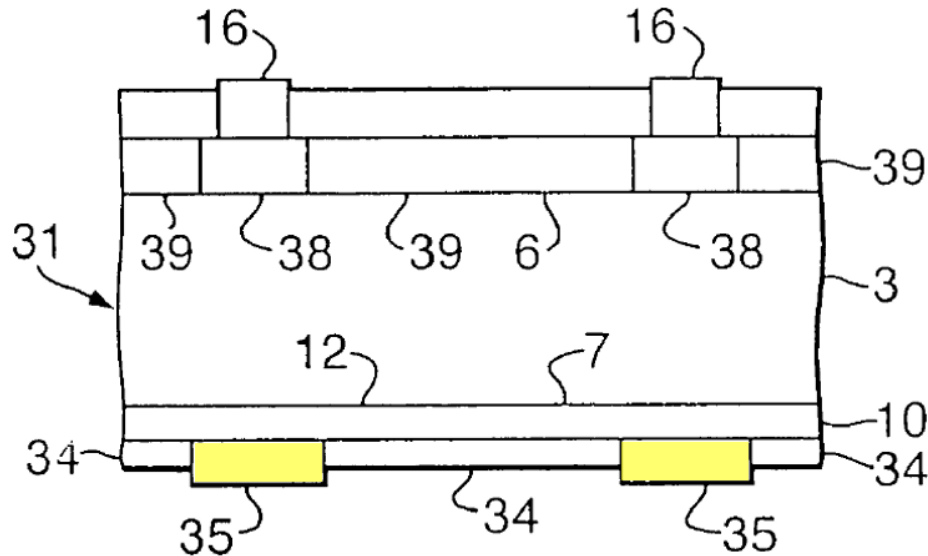
Froitzheim used an *N-type silicon substrate*. EX1006, ¶24; EX1003, ¶177. Froitzheim’s *emitter layer comprised P-type doped silicon*. EX1006, ¶¶25-26. In the combination of Froitzheim/Gan, Froitzheim’s p-type diffused emitter would be replaced with a p-type *polysilicon* emitter as taught by Gan. §X.B; EX1003, ¶177. Because the Froitzheim/Gan combination merely replaces the diffused emitter in Froitzheim with a polysilicon emitter with interfacial oxide layer, as taught by Gan, the combination meets this element in claim 11. EX1003, ¶177.

4. Claim 12

Claim 12 depends from claim 9 and recites: “*wherein the second metal contact comprises silver formed over a layer of silicon dioxide.*” Froitzheim disclosed this element.

First, Froitzheim disclosed that its rear contacts (*second metal contact*) are metal contacts that comprise silver and aluminum. EX1003, ¶179; EX1006 ¶¶49, 60.

Second, FIG. 3 of Froitzheim disclosed an alternative embodiment of the back contacts 35 (yellow) where only a portion of the back is screen-printed. EX1003, ¶180; EX1006, ¶33. “In this way, less material such as *Ag [i.e., silver]* or Al is required for the contacts, which could have the shape of a finger structure.” EX1006, ¶20. Layer 34 in FIG. 3 is identified as a passivation layer “for which the same type of layers can be used as for the front side.” EX1006, ¶33. Froitzheim expressly disclosed that silicon dioxide (“SiO₂”) is one of the possible passivation material on the front side, and thus it could also be used for layer 34 on the back side because Froitzheim taught the same type of passivation layer can be used for both front and back. EX1006, ¶¶19, 30, 33.



Finally, 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. EX1006, ¶¶19,33,50; EX1003, ¶181.

Because the Froitzheim/Gan combination merely replaces the diffused emitter in Froitzheim with a polysilicon emitter with interfacial oxide layer, as taught by Gan, the combination meets this element in claim 12.⁷ EX1003, ¶182.

XI. CLAIMS 9-12 ARE UNPATENTABLE OVER FROITZHEIM AND KWARK

Froitzheim disclosed all elements of claims 9-12 except for the (1) polysilicon emitter in claim 11 and (2) the oxide layer in between the emitter and substrate in claim 9. However, just as taught by Gan, Kwark similarly would have supplied these two missing elements, and the Skilled Artisan would be motivated combine Froitzheim and Kwark.

A. Kwark (EX1008) Overview

Kwark et al. “SIPOS Heterojunction contacts to silicon,” International Electron Devices Meeting (1984): 742-745 (“Kwark”) was a paper presented in 1984 (EX1008, face, viii) and the paper was published at least by 1986 but no later

⁷ To the extent it is argued (incorrectly) that the rear finger contacts of Froitzheim are a separate embodiment from that relied upon elsewhere, the Skilled Artisan would have found it obvious to modify Froitzheim Figure 1 with the disclosed rear contact fingers and passivation because “less material such as Ag [*i.e.*, silver] or Al is required for the contacts.” EX1006, ¶20; EX1003, ¶183. A Skilled Artisan would have a reasonable expectation of success making this predictable adaptation. EX1003, ¶183.

than August 9, 2005 when it was made publicly available for electronic download at IEEE Xplore, and in any event was publicly available before February 20, 2007. EX1024, ¶¶6, 29, 52-58; EX1043; EX1044. Kwark was widely distributed and has also been known and cited by others in the field at least by 1997, including in a US Patent that issued in 1997, further confirming its public dissemination before February 20, 2007. EX1024, ¶58; EX1045. Exhibit 1008 is an authentic copy of Kwark that was published before February 20, 2007. EX1024, ¶¶6, 52-58. Thus, it is prior art under 35 U.S.C. §102(a) and (b).

Kwark tested polysilicon films with and without an intervening chemically grown oxide layer, and found that the oxide layer greatly decreased emitter saturation current—a characteristic Kwark noted translates into potential improvements for solar cell efficiency (EX1008, 742). Kwark reported that addition of “POLY” (*i.e.*, polysilicon emitter) without the “chemox” (*i.e.*, chemically formed oxide layer) “does not greatly impact J_{oe} as would be expected” where J_{oe} was a measure of emitter saturation current and solar cell recombination. However, when the “chemox” was present, it “greatly decrease[d] the J_{oe} as has been previously reported.” EX1008, 743. Kwark illustrated this decrease in J_{oe} with the “chemox” in Figure 4:

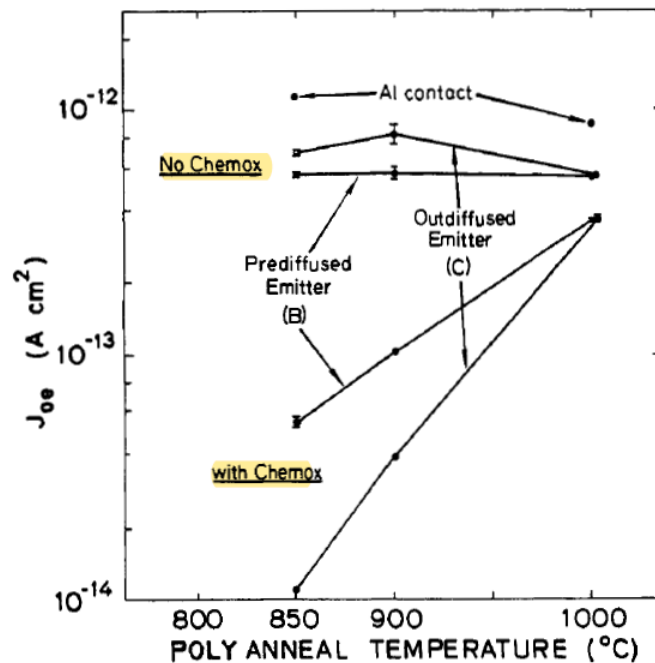
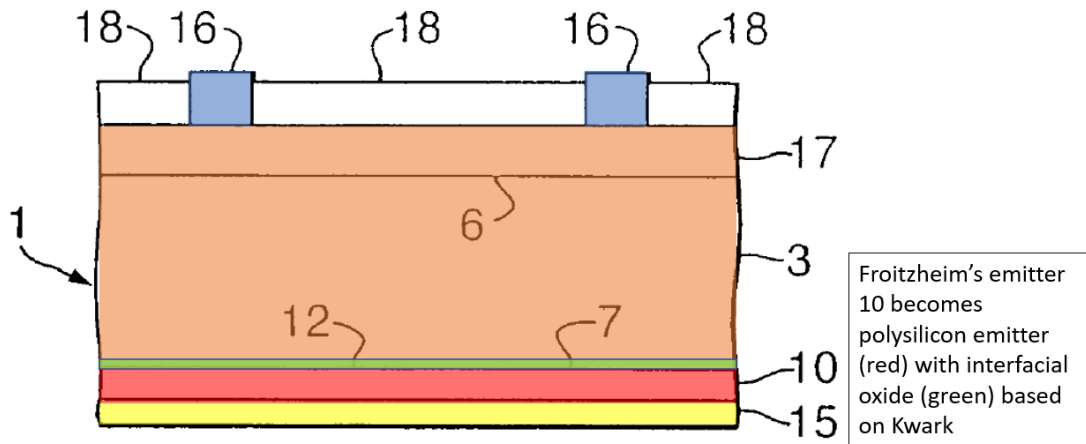


Fig. 4: emitter saturation current for POLY contacts with and without a chemically grown interfacial layer vs. anneal temperature. Thicknesses range from 3000-3600 angstroms. Note the large difference when the interfacial oxide is missing.

Based on Kwark's teaching, it would have been obvious to the Skilled Artisan to replace Froitzheim's p-type emitter with a p-type *polysilicon* emitter along with an interfacial oxide layer between the emitter and the substrate, as taught by Kwark. EX1003, ¶¶186-187.



B. Motivation to Modify Froitzheim with Kwark

Froitzheim and Kwark are analogous art because each is in the same field of endeavor—solar cell design.⁸ EX1001, 1:15-17; EX1003, ¶188; EX1006, Abstract, ¶¶1,9; EX1008, 742. Each is reasonably pertinent to the problems of efficiencies in solar cell designs. EX1001, 1:40-42; EX1003, ¶188; EX1006, Abstract, ¶¶1,9; EX1008, 742.

The Skilled Artisan would have been motivated to modify Froitzheim's emitter to be a polysilicon emitter with an oxide layer because Kwark taught that this modification would be an improvement. EX1003, ¶189. Kwark first taught that replacing the conventional emitter with an "SIPOS" emitter "has been previously shown to reduce the emitter saturation current, Joe, by at least a factor

⁸ To the extent it is argued Kwark is directed to a bipolar transistor, a Skilled Artisan would have looked to it when designing solar cells as was commonly done in the art. EX1003, ¶188; EX1020, 363; EX1021, 497; EX1007, 245; EX1016, 597.

of fifty.” EX1008 (Abstract). Kwark then showed that using pure polysilicon emitter produced “surprising[ly]” similar “good results” as the SIPOS emitter.

EX1008, 742; EX1003, ¶189. Kwark further taught, with supporting data in FIG.

4, that the addition of an interfacial chemically grown oxide (chemox) between the polysilicon emitter and the substrate “greatly decreases the J_{oe} ,” which “translates into potential improvements of energy conversion efficiency for solar cells.”

EX1008, 742, 745.

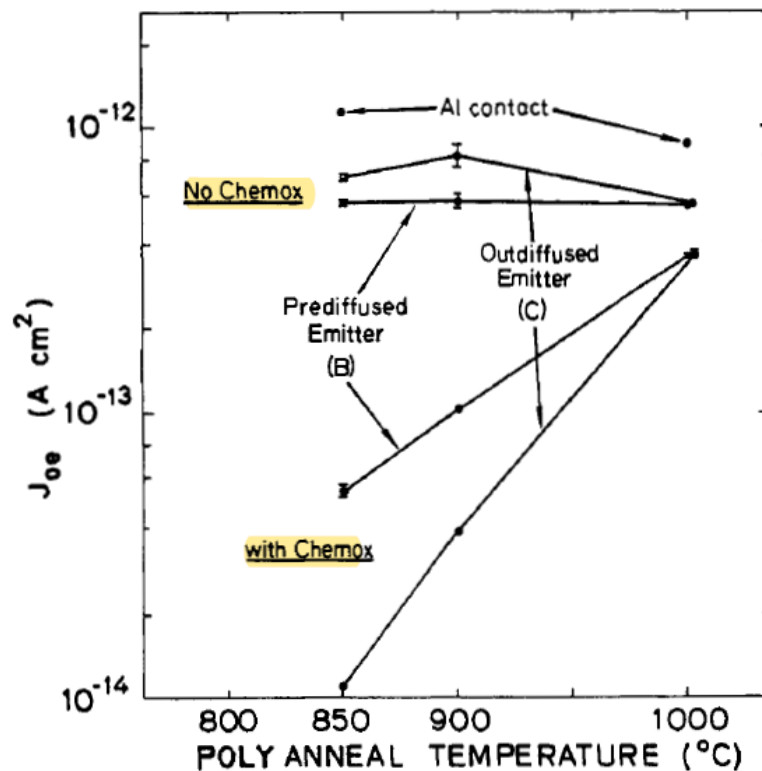


Fig. 4: emitter saturation current for POLY contacts with and without a chemically grown interfacial layer vs. anneal temperature. Thicknesses range from 3000-3600 angstroms. Note the large difference when the interfacial oxide is missing.

The teachings of Gan, Foglietti, and Borden discussed in §X.B.1 would similarly have motivated a Skilled Artisan to integrate a polysilicon emitter with interfacial oxide layer in Froitzheim in view of Kwark. EX1003, ¶190.

C. Reasonable Expectation of Success

The Skilled Artisan would have considered the Froitzheim/Kwark 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 modification as taught by Kwark (a solar cell with improved performance). EX1003, ¶191.

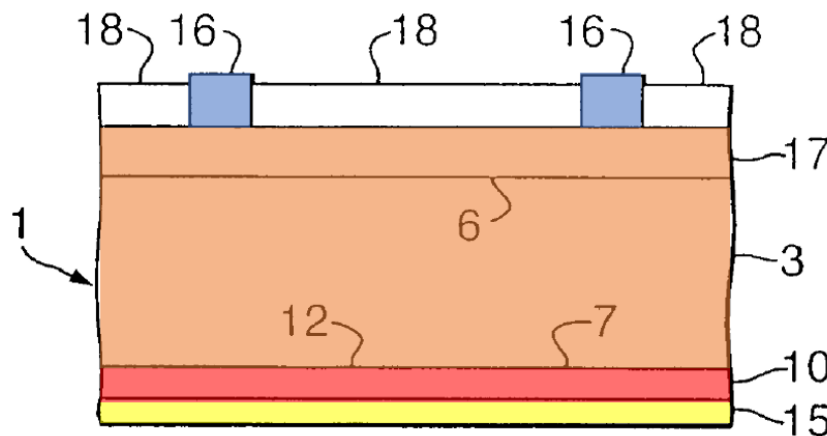
Combining Froitzheim/Kwark as described here would have been well within the level of ordinary skill in the art. EX1003, ¶192. It would not have resulted in any unpredictable results and could have been readily accomplished without undue experimentation and with a reasonable expectation of success. *Id.* Substituting Froitzheim's emitter with a polysilicon emitter and oxide layer would be simple substitution of one known prior art element for another to obtain predictable results. *Id.* It would further constitute use of a known technique (polysilicon emitters with an oxide layer) to improve similar devices (Froitzheim's solar cell) in the same way. *Id.*

D. Froitzheim and Kwark Disclosed All Elements

For the same reasons as discussed in §§X.C.1.a), X.C.1.b), X.C.1.c), X.C.1.e), X.C.1.f), X.C.2, X.C.3, and X.C.4, Froitzheim disclosed all elements of claims 9-12, except for the (1) polysilicon emitter in claim 11 and (2) [9c] the oxide layer in between the polysilicon and substrate in claim (9). EX1003, ¶193.

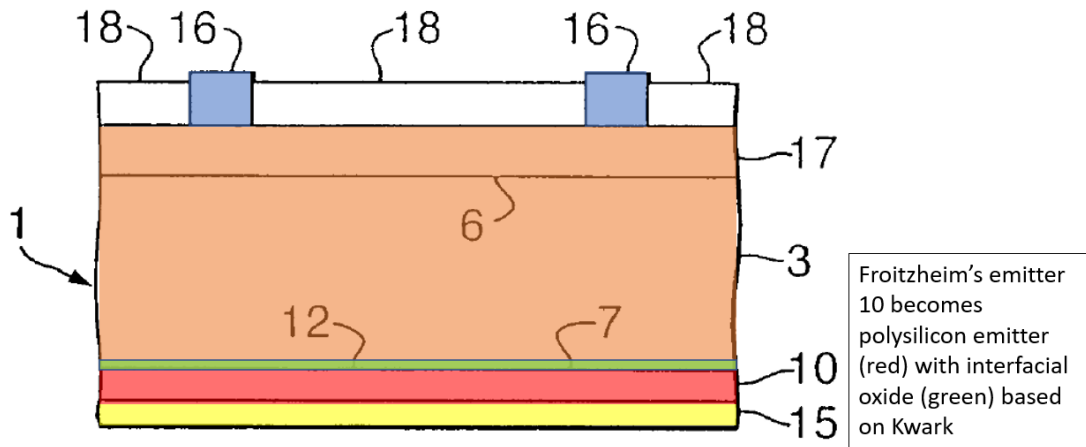
a) [9.b] Back emitter and claim 11's polysilicon emitter

Froitzheim disclosed “an emitter layer formed over a back surface of the substrate, the emitter layer forming a backside junction with the substrate,” as recited in claim 9. EX1003, ¶194. This is shown by red p-type doped emitter 10 (red) in the figure below forming PN junction 12 on the backside of the solar cell (backside junction). EX1006, ¶¶24-27.



Claim 11 requires the “emitter layer” to be a “polysilicon layer.” In the Froitzheim/Kwark combination, Froitzheim’s diffused p-type emitter is replaced with a p-type polysilicon emitter as taught by Kwark. EX1003, ¶195. This modified polysilicon emitter meets the claim as it is *formed over a back surface of*

the substrate and forms a *backside junction* (PN junction) 12 with the n-type substrate. EX1003, ¶195. Thus, the Froitzheim/Kwark combination meets claim 11's requirement of a polysilicon emitter.



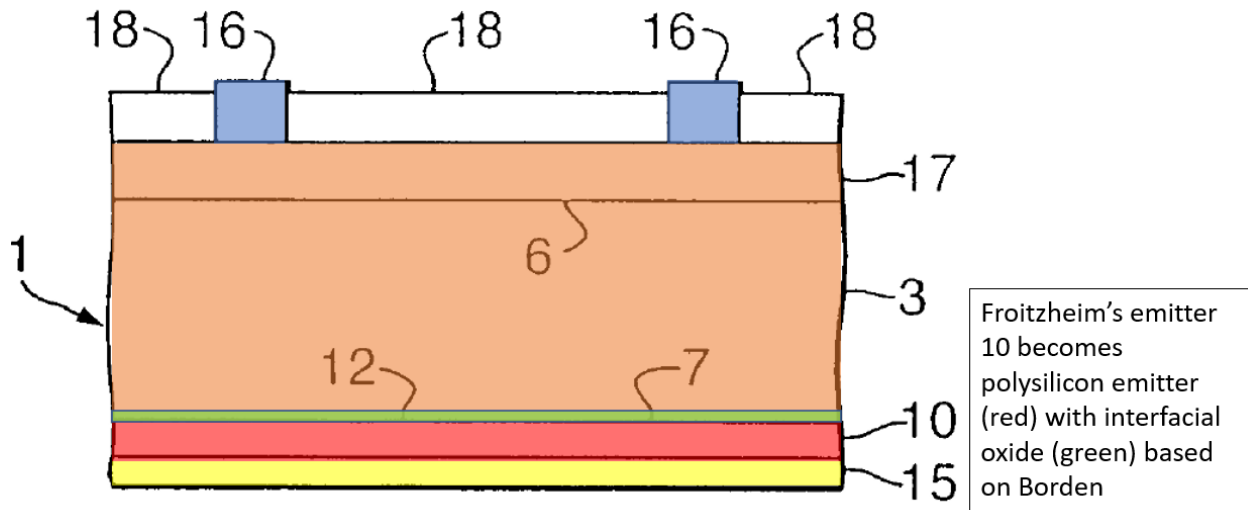
b) [9.c] Oxide layer

Froitzheim does not disclose “*an oxide layer formed between the back surface of the substrate and the emitter layer.*” However, as described in §§XI.B-XI.C, the Skilled Artisan would be motivated to modify Froitzheim with a polysilicon layer and include an oxide layer in between because of the improvement in solar cell that it can achieve, as taught by Kwark. EX1003, ¶196. With supporting data in FIG. 4, Kwark showed that with an intervening chemically grown oxide layer, the emitter saturation current was greatly decreased—a characteristic that Kwark noted translates into potential improvements for solar cell efficiency. EX1008, 742. Thus, the combination of Froitzheim and Kwark would have rendered claims 9-12 obvious. EX1003, ¶¶193-196.

XII. CLAIMS 9-12 ARE UNPATENTABLE OVER FROITZHEIM IN VIEW OF BORDEN

In the same way, Claims 9-12 would have been rendered obvious by the combination of Froitzheim and Borden. Like Gan and Kwark, Borden taught the use of an interfacial oxide layer in between a polysilicon emitter and substrate, and it would have been obvious to replace the backside diffused emitter of Froitzheim with the polysilicon layer and interfacial oxide layer, as taught by Borden.

EX1003, ¶197.



A. Motivation to Modify Froitzheim with Borden

Froitzheim and Borden are analogous art because each is in the same field of solar cell design. EX1003, ¶198; EX1006, Abstract, ¶¶1,9; EX1009, ¶16. Each is reasonably pertinent to addressing the problems of solar cell designs. EX1003, ¶198; EX1006, Abstract, ¶¶1,9; EX1009, ¶16.

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.

B. Reasonable Expectation of Success

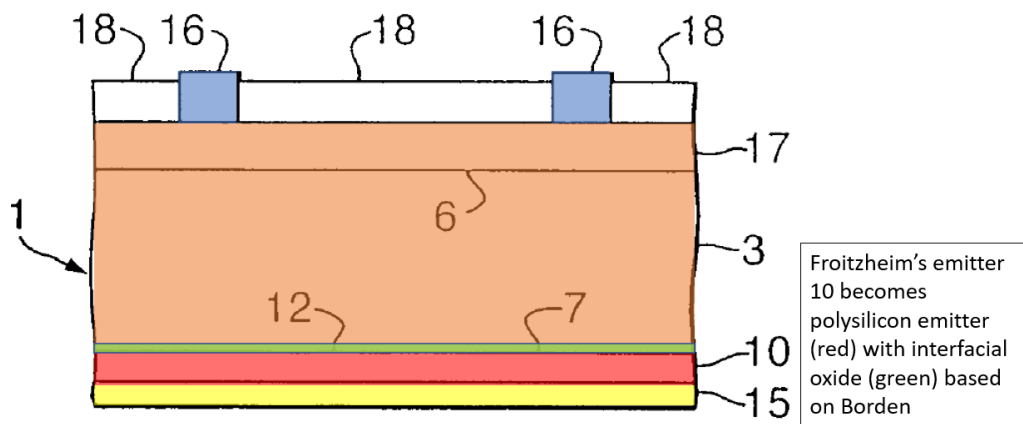
The Skilled Artisan would have considered the Froitzheim/Borden combination to be merely an arrangement of old elements with each performing the same function it had been known to perform and yielding no more than what one would expect from such an arrangement. EX1003, ¶200. Combining Froitzheim/Borden as described here would also have been well within the level of ordinary skill in the art, would not have resulted in any unpredictable results and could have been readily accomplished without undue experimentation and with a reasonable expectation of success. *Id.* It constitutes nothing more than applying a known technique to a known device ready for improvement to yield predictable results. *Id.*

C. Froitzheim and Borden Disclosed All Elements

For the same reasons as discussed in §§X.C.1.a), X.C.1.b), X.C.1.c), X.C.1.e), X.C.1.f), X.C.2, X.C.3, and X.C.4, Froitzheim disclosed all elements of claims 9-12, except for the (1) polysilicon emitter in claim 11 and (2) [9c] the oxide layer in between the polysilicon and substrate in claim 9. EX1003, ¶201.

a) [9.b] Back emitter and claim 11's polysilicon emitter

In the Froitzheim/Borden combination, Froitzheim's emitter is replaced with a polysilicon emitter and oxide layer as taught by Borden. This modified emitter meets the claim as it is *formed over a back surface of the substrate* and forms a *backside junction* (PN junction) 12 with the substrate. EX1003, ¶202.



b) [9.d] Oxide layer

Although Froitzheim did not disclose an intervening oxide layer, Borden did. Borden disclosed “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.” EX1009, ¶16. The Skilled Artisan would have been motivated

to include an interfacial oxide layer in a modified Froitzheim cell because it “prevents epitaxial growth,” allowing for “optimum band structure” and “provides a layer to protect the surface from plasma damage,” as taught by Borden. EX1009, Abstract. EX1003, ¶203.

XIII. OBJECTIVE FACTORS SUPPORT OBVIOUSNESS

There is no commercial success attributable to the 516 Patent claims. EX1003, ¶¶204-216. Neither Maxeon nor its predecessor SunPower practiced the 516 Patent because their commercial products are all back-contact solar cells, rather than front contact solar cells. EX1003, ¶¶205-207. Back contact solar cells have both first and second metal contacts on the backside, unlike the claimed invention of the ‘516 Patent that requires front and back metal contacts. *Id.* Moreover, there are no unexpected results in replacing the backside diffused emitter in a back junction solar cell like Meier and Froitzheim with a polysilicon emitter having an interfacial oxide layer in between. EX1003, ¶217. The Skilled Artisan would have expected to reap benefits from such modification such as higher solar cell efficiencies and lower recombination, as seen by the prior art such as Kwark, Gan, Borden, and Foglietti. *Id.* And including an oxide layer between the polysilicon layer and the substrate of a solar cell with front and back metal contacts was well known to confer expected benefits as well. *Id.* Making such a

modification to Meier and Froitzheim was simply following the conventional wisdom. *Id.*

XIV. CONCLUSION

Claims 9-12 should be canceled as unpatentable.

Dated: June 24, 2024

Respectfully submitted,

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CERTIFICATE OF COMPLIANCE

I hereby certify that this brief complies with the type-volume limitations of 37 C.F.R. § 42.24, because it contains 13,392 words (as determined by the Microsoft Word word-processing system used to prepare the brief), excluding the parts of the brief exempted by 37 C.F.R. § 42.24.

Dated: June 24, 2024

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Petition for *Inter Partes* Review of U.S. Patent No. 8,222,516

**PETITION FOR INTER PARTES REVIEW
OF U.S. PATENT NO. 8,222,516**

**Attachment A:
Proof of Service of the Petition**

CERTIFICATE OF SERVICE

I hereby certify that on this 24th day of June, a copy of this Petition, including all attachments, appendices and exhibits, has been served in its entirety by overnight mail on the following counsel of record for patent owner:

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Dated: June 24, 2024

Respectfully submitted,

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Attachment B:

List of Evidence and Exhibits Relied Upon in Petition

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Exhibit #	Reference Name
1001	U.S. Patent No. 8,222,516 (“516 Patent”)
1002	File History of U.S. Patent No. 8,222,516
1003	Declaration of Sanjay Banerjee
1004	Curriculum Vitae of Sanjay Banerjee
1005	File History of U.S. Patent Application No. 14/504,771 (“771 Application”)
1006	EP1732142A1 to Armin Froitzheim (“Froitzheim”)
1007	J.Y. Gan et al., “Polysilicon Emitters for Silicon Concentrator Solar cells,” May 1990, Proceedings of the 21st IEEE-PVSC (“Gan”)
1008	Kwark, Y. H. et al. “SIPOS Heterojunction contacts to silicon.” 1984 International Electron Devices Meeting (1984): 742-745 (“Kwark”)
1009	WO2009/094578 to Borden (“Borden”)
1010	U.S. Provisional Patent Application No. 61/023,342 (EX1010) (“Borden Provisional”), filed January 24, 2008.
1011	U.S. Patent No. 6,262,359 to Meier (“Meier”)
1012	JP07-106611 to Okayasu (“Okayasu”) (Human Translation)
1013	JP07-106611 to Okayasu (“Okayasu”) (Japanese Original)
1014	U.S. Patent Pub. No. 2002/0142500 to Foglietti
1015	U.S. Patent Pub. No. 2005/0268963 to Jordan (“Jordan”)
1016	Yablonovitch, Eli et al., “A Study of n ⁺ -SIPOA:p-Si Heterojunction Emitters.” Nov. 1985, IEEE Election Device Letters, Vol. EDL-6, No. 11 (“Yablonovitch”)
1017	Sinton, R. A. et al., “Design Criteria for Si Point-Contact Concentrator Solar Cells.” Oct. 1987, IEEE Trans. on Electron Devices, Vol. ED-34, No. 10

Exhibit #	Reference Name
1018	File History of U.S. Patent Application No. 16/460,035 (“035 Application”)
1019	Luque, A. et al., “Handbook of Photovoltaic Science and Engineering.” Wiley (2003)
1020	Lindholm, F.A., et al., “Heavily Doped Polysilicon-Contact Solar Cells.” July 1985, IEEE Electron Device Letters, Vol. EDL-6, No. 7
1021	Silvestre, S. et al., “Series Resistance in Double-Polysilicon-Contacted Silicon Solar Cells.” May 13-17, 1996, IEEE 25th PVSC
1022	Duerinckx, F. et al., “Defect passivation of industrial multicrystalline solar cells based on PECVD silicon nitride.” 2002, Elsevier, Solar Energy Materials & Solar Cells
1023	Ashburn, P. et al., “Comparison of Experimental and Theoretical Results on Polysilicon Emitter Bipolar Transistors.” July 1984, IEEE Trans. on Electron Devices, Vol. ED-31, No. 7
1024	Declaration of Sylvia Hall-Ellis
1025	Curriculum Vitae of Sylvia Hall-Ellis
1026	June 21, 2022 Director Memo
1027	DocketNavigator Report
1028	Kass, D., “Fintiv Fails: PTAB Uses ‘Remarkably Inaccurate’ Trial Dates.” (Fintiv study) https://www.law360.com/articles/1436071/print?section=ip
1029	Letter from Senator Thom Tillis to Andrew Hirshfeld, dated Nov. 2, 2021 (Senator Tillis Letter)
1030	Press Release, SunPower and Maxeon Solar Technologies Close Spin-Off Transaction, dated Aug. 27, 2020 https://newsroom.sunpower.com/2020-08-27-SunPower-and-Maxeon-Solar-Technologies-Close-Spin-Off-Transaction

Exhibit #	Reference Name
1031	Patent Assignment
1032	U.S. Patent No. 6,998,288 to Smith (“Smith288”)
1033	SunPower Virtual Patent Marketing https://us.sunpower.com/solar-panels-technology/patents
1034	Patents Maxeon Solar Technologies, Ltd. https://corp.maxeon.com/patents
1035	Press Release, SunPower and Maxeon Solar Technologies Close Spin-Off Transaction, dated Aug. 27, 2020 https://mediaroom.maxeon.com/2020-08-27-SunPower-and-Maxeon-Solar-Technologies-Close-Spin-Off-Transaction
1036	SunPower Maxeon Solar Panels https://sunpower.maxeon.com/int/solar-panel-products/maxeon-solar-panels
1037	Feldman, et al., “A Passivated Rear Contact for High-Efficiency n-Type Silicon Solar Cells Enabling High VocS and FF > 82%” at 1 (28th European PV Solar Energy Conference & Exhibition, Paris, Sept. 30 – Oct. 4, 2013) (“Feldman Paper”).
1038	File History of U.S. Patent No. 8,878,053
1039	Green, M.A. et al., “High Efficiency N-Silicon Solar Cells Using Rear Junction Structures.” IEEE (1993)
1040	<i>Reserved</i>
1041	<i>Reserved</i>
1042	<i>Reserved</i>
1043	OSTI Kwark Entry, https://www.osti.gov/biblio/5905985
1044	IEEE Xplore Kwark Entry, https://ieeexplore.ieee.org/document/1484603

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Exhibit #	Reference Name
1045	U.S. Patent No. 5,661,079
1046	IEEE Xplore Gan Entry, https://ieeexplore.ieee.org/document/111625
1047	IEEE Xplore Lemiti Entry, <a href="https://ieeexplore.ieee.org/abstract/document/520203/references#citati
ons">https://ieeexplore.ieee.org/abstract/document/520203/references#citati ons
1048	M. Lemiti, B. Semmache, Q. N. Le, D. Barbier and A. Laugier, “Physical properties of RT-LPCVD and LPCVD polysilicon thin films: application to emitter solar cell,” Proceedings of 1994 IEEE 1st World Conference on Photovoltaic Energy Conversion – WCPEC (A Joint Conference of PVSC, PVSEC ands PSEC), Waikoloa, HI, USA, 1994, pp. 1375-1378 vol.2.

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**Attachment C:
Listing of the Claims of 8,222,516**

Claim Element	Claim Language
[9.a]	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:
[9.b]	a substrate having a textured front surface;
[9.c]	an emitter layer formed over a back surface of the substrate, the emitter layer forming a backside junction with the substrate;
[9.d]	an oxide layer formed between the back surface of the substrate and the emitter layer;
[9.e]	a first metal contact making an electrical connection to the substrate on the front side of the solar cell; and
[9.f]	a second metal contact making an electrical connection to the emitter layer on the backside of the solar cell,
[9.g]	the first metal contact and the second metal contact being configured to allow an external electrical circuit to be powered by the solar cell.
[10]	10. The solar cell of claim 9 further comprising an antireflective layer over the textured front surface of the substrate.
[11]	11. The solar cell of claim 9 wherein the substrate comprises an N-type silicon substrate and the emitter layer comprises a P-type doped polysilicon.
[12]	12. The solar cell of claim 9 wherein the second metal contact comprises silver formed over a layer of silicon dioxide.

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Attachment D:

Comparison of Challenged Claims to 771/035 Application Claims

'516 Patent Claims 9-12	'771 Application Claims 1-2, 4, 7	'035 Application Claims 21, 23-25
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: [9a] a substrate having a textured front surface:	1. A solar cell, comprising: a substrate having a front surface that faces the sun to collect solar radiation during normal operation and a back surface opposite the front surface;	21. A solar cell, the solar cell comprising: a N-type silicon substrate having a front surface and a back surface, wherein the front surface comprises a textured surface;
<i>[Claim 10. The solar cell of claim 9 further comprising an antireflective layer over the textured front surface of the substrate.]</i>	[1] an oxide layer disposed on the front surface of the substrate; an anti-reflective coating on the oxide layer;	[21] an antireflective layer over the front surface of the N-type silicon substrate
		[21] a plurality of dot-shaped N-type doped regions in the N-type silicon substrate under the antireflective layer, each of the plurality of dot-shaped doped regions having a dot shape

'516 Patent Claims 9-12	'771 Application Claims 1-2, 4, 7	'035 Application Claims 21, 23-25
		as seen from a plan view of the solar cell;
[9b] an emitter layer formed over a back surface of the substrate, the emitter layer forming a backside junction with the substrate; [9c] an oxide layer formed between the back surface of the substrate and the emitter layer;	[1] a tunnel dielectric disposed over the back surface of the substrate; an emitter disposed over the tunnel dielectric, the emitter forming a backside junction with the substrate; [4. <i>The solar cell of claim 1, wherein the tunnel dielectric is a <u>tunnel oxide</u></i>]	[21] an oxide region disposed over the back surface of the N-type silicon substrate; a polysilicon emitter disposed over the oxide region;
	[1] a doped diffusion region in the substrate;	
[9d] a first metal contact making an electrical connection to the substrate on the front side of the solar cell; and	[1] a front electrode that is coupled to the doped diffusion region on the front surface of the substrate; and	[21] a first metal contact disposed on the front surface of the N-type silicon substrate, wherein the first metal contact is in electrical contact with the plurality of dot-shaped N-type doped regions; and

'516 Patent Claims 9-12	'771 Application Claims 1-2, 4, 7	'035 Application Claims 21, 23-25
[9e] a second metal contact making an electrical connection to the emitter layer on the backside of the solar cell,	[1] a back electrode that is coupled to the emitter on the back surface of the substrate.	[21] a second metal contact disposed on the polysilicon emitter.
[9f] the first metal contact and the second metal contact being configured to allow an external electrical circuit to be powered by the solar cell.		
11 The solar cell of claim 9 wherein the substrate comprises an N-type silicon substrate and the emitter layer comprises a P-type doped polysilicon	2. The solar cell of claim 1, wherein the emitter is a polysilicon emitter .	23. The solar cell of claim 21, wherein the polysilicon emitter comprises a P-type doped polysilicon .
12 The solar cell of claim 9 wherein the second metal contact comprises silver formed over a layer of silicon dioxide	7. The solar cell of claim 1, wherein the back electrode includes silver .	24. The solar cell of claim 21, further comprising a dielectric layer over the polysilicon emitter. 25. The solar cell of claim 24, wherein the dielectric

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'516 Patent Claims 9-12	'771 Application Claims 1-2, 4, 7	'035 Application Claims 21, 23-25
		layer comprises silicon dioxide .