

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

HANWHA SOLUTIONS CORPORATION,

Petitioner,

v.

MAXEON SOLAR PTE. LTD.,

Patent Owner.

Case No. IPR2024-01199

U.S. Patent No. 8,878,053

**PETITION FOR *INTER PARTES* REVIEW
OF CLAIMS 1-20 OF
U.S. PATENT NO. 8,878,053
UNDER 35 U.S.C. §312 AND 37 C.F.R. §42.104**

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I. INTRODUCTION

U.S. Patent No. 8,878,053 (“’053 patent”) claims solar cell fabrication processes that were well known in the prior art. The claimed fabrication processes—manufacturing a solar cell by providing a substrate, forming an emitter on the back side of the substrate to make a backside junction, and (for independent claim 16) forming an oxide layer between the substrate and the emitter—were taught by a host of prior art references that the Examiner did not receive or consider.

For example, it was well known that a solar cell must have a PN junction to create usable electricity, and skilled artisans (“POSITAs”) would place this junction on the back side of the solar cell. It was also well known that the oppositely doped substrate and emitter create a PN junction, and emitters were typically formed by either diffusing a dopant into the substrate or depositing a new layer on the substrate. POSITAs recognized these techniques were interchangeable, and it was known that a polysilicon emitter with an oxide layer between the emitter and substrate was advantageous over a diffused emitter. As explained herein, a POSITA would have been motivated to fabricate a solar cell that had the benefits of a backside junction and a polysilicon emitter with an oxide layer structure, using processing steps designed to simplify production, to achieve the predictable result of producing more efficient solar cells at lower manufacturing costs.

Moreover, this Petition should not be discretionarily denied. This Petition presents information that was not considered by the Examiner and directly addresses the reasons the Examiner gave for allowing the Challenged Claims. Additionally, Patent Owner (“PO”) has asserted the ’053 patent in an ongoing litigation campaign, including against Petitioner and Canadian Solar Incorporated (“CSI”). CSI filed an *inter partes* review (“IPR”) petition approximately one month ago challenging claims 9-20 of the ’053 patent. This Petition should not be denied in view of CSI’s petition because this Petition is responsive to PO’s accusations against Petitioner, there is no relationship between Petitioner and CSI, this Petition challenges *all*—instead of a subset of—claims, and minimal time separates the petitions.

Accordingly, Petitioner respectfully requests institution of *inter partes* review and cancellation of the Challenged Claims.

II. MANDATORY NOTICES

A. Real Parties in Interest

Pursuant to 37 C.F.R. §42.8(b)(1), Petitioner certifies that Hanwha Solutions Corporation is the real party-in-interest.

B. Related Matter

Pursuant to 37 C.F.R. §42.8(b)(2), Petitioner discloses that Patent Owner (“PO”) has asserted U.S. Patent Nos. 8,222,516 (“’516 patent”), 8,878,053 (“’053 patent”), and 11,251,315 (“’315 patent”) against Petitioner in *Maxeon Solar Pte. Ltd.*

v. Hanwha Solutions Corporation and Hanwha Energy Corporation, No. 2:24-cv-00262 (E.D. Tex.). *See* Ex.1014-Complaint.

PO has also asserted these patents in the following proceedings:

- *Maxeon Solar Pte. Ltd. v. Canadian Solar Inc.*, No. 2:24-cv-00210 (E.D. Tex.); and
- *Maxeon Solar Pte. Ltd. v. REC Solar Holdings AS*, No. 2:24-cv-00260 (E.D. Tex.).

On June 24 and 25 and July 19, 2024, Canadian Solar Incorporated (“CSI”) filed *inter partes* review petitions challenging a subset of claims of each of the ’516, ’053, and ’315 patents:

Challenged Patent No.	Challenged Claims	Case No.
8,222,516	9-12	IPR2024-01039
8,878,053	9-20	IPR2024-01040
11,251,315	10-15	IPR2024-01038
11,251,315	16, 19	IPR2024-01194

Petitioner is concurrently filing *inter partes* review petitions challenging all claims of the ’516 and ’053 patents and a substantial subset of claims of the ’315 patent:

Challenged Patent No.	Challenged Claims	Case No.
8,222,516	1-12	IPR2024-01203
8,878,053	1-20	IPR2024-01199
11,251,315	10-20	IPR2024-01198

Petitioner further discloses that a U.S. patent application claiming priority to the '516 and '053 patents is currently pending as Application No. 17/870,268.

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III. CERTIFICATION OF GROUNDS FOR STANDING

Petitioner certifies the '053 patent is available for IPR, and Petitioner is not barred or estopped from requesting IPR on the grounds identified herein.

IV. OVERVIEW OF CHALLENGE AND RELIEF REQUESTED

Petitioner requests cancellation of claims 1-20 ("Challenged Claims").

A. Prior Art

The '053 patent was filed on June 13, 2012, and claims priority to the '516 patent, which was filed on February 20, 2008. Ex.1001-USP053, Cover. Petitioner relies upon the following patents and printed publications:

1. EP 1,732,142A1 to Froitzheim (“Froitzheim,” Ex.1004), which was published on December 13, 2006 and is prior art at least under 35 U.S.C. §102(b).
2. Gan and Swanson, *Polysilicon Emitters for Silicon Concentrator Solar Cells*, IEEE Conference on Photovoltaic Specialists, Vol. 1, Pages 245-250 (1990) (“Gan,” Ex.1005), which is prior art at least under 35 U.S.C. §102(b). As the declaration of June Munford confirms, Gan was publicly available at least over one year before the earliest alleged priority date of the ’053 patent. Ex.1013-Munford-Decl., ¶¶14-21; *Telefonaktiebolaget LM Ericsson v. TCL Corp.*, 941 F.3d 1341, 1346-47 (Fed. Cir. 2019).
3. U.S. Patent No. 6,998,288 to Smith (“Smith,” Ex.1007), which issued on February 14, 2006 and is prior art at least under 35 U.S.C. §102(b).
4. CN 1949545A to Li (“Li,” Ex.1008),¹ which was published on April 18, 2007 and is prior art at least under 35 U.S.C. §102(a).

B. Grounds for Challenge

Petitioner requests cancellation of the Challenged Claims as unpatentable under 35 U.S.C. §103. The grounds are:

Ground	35 U.S.C. §	Claims	Reference(s)
I	103	9-12, 14, 16-20	Froitzheim and Gan

¹ See Ex.1009 (translator declaration).

Ground	35 U.S.C. §	Claims	Reference(s)
II	103	1-20	Froitzheim, Gan, and Smith
III	103	9-20	Li, Gan, and Smith

This Petition, supported by the declaration of Dr. Zachary Holman (Ex.1003), demonstrates there is a reasonable likelihood that Petitioner will prevail with respect to at least one challenged claim. 35 U.S.C. §314(a). Petitioner respectfully requests institution. *SAS Inst. v. Iancu*, 138 S. Ct. 1348 (2018).

V. TECHNOLOGY BACKGROUND

A. Solar Cells

A solar cell is an electrical device that converts solar radiation (sunlight) into electricity. An individual solar cell, when exposed to sunlight, generates a flow of electricity for external circuits. To generate usable amounts of energy, multiple cells are connected to form a solar module:



Ex.1017-BP-MSX-120, 1. Ex.1003-Decl., ¶42.

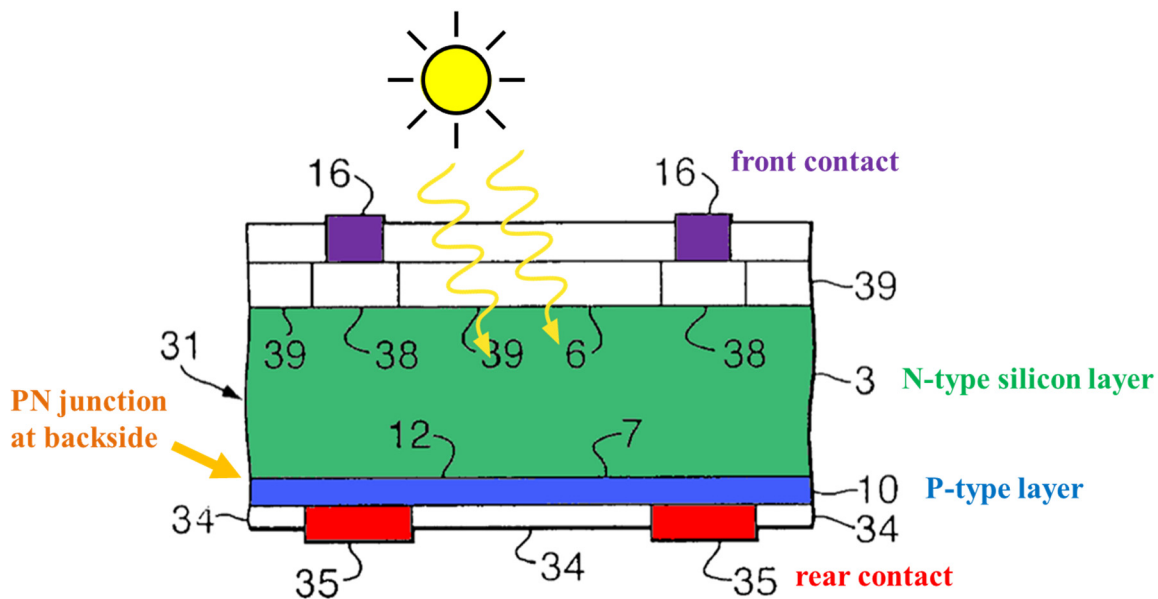
POSITAs have studied the structure and manufacture of solar cells for decades. A solar cell typically has multiple silicon layers. Two variants of silicon are commonly used: (i) silicon, which has a monocrystalline lattice, and (ii) polysilicon, which has multiple crystalline regions that are not aligned with each other. Amorphous silicon, which has a non-crystalline lattice, is sometimes utilized. Ex.1003-Decl., ¶43.

In a standard solar cell, a chemical element, typically boron or phosphorus, is introduced to the cell. The process for introducing these elements is known as “doping,” and techniques for doping silicon and polysilicon layers were well-established by 2008. A common doping technique involved forming a glass layer with dopants over a silicon or polysilicon layer and then subjecting the combined materials to high temperatures in a furnace to drive dopants from the glass into the silicon or polysilicon. Boron was commonly used to create “p-type” layers, and phosphorous was commonly used to create “n-type” layers. Ex.1003-Decl., ¶¶44-55.

For a solar cell to create energy, an interface between the n-type and p-type layers must be formed, which was commonly known as the “PN” junction. When solar radiation reaches a cell, the solar energy causes the release of an electron-hole

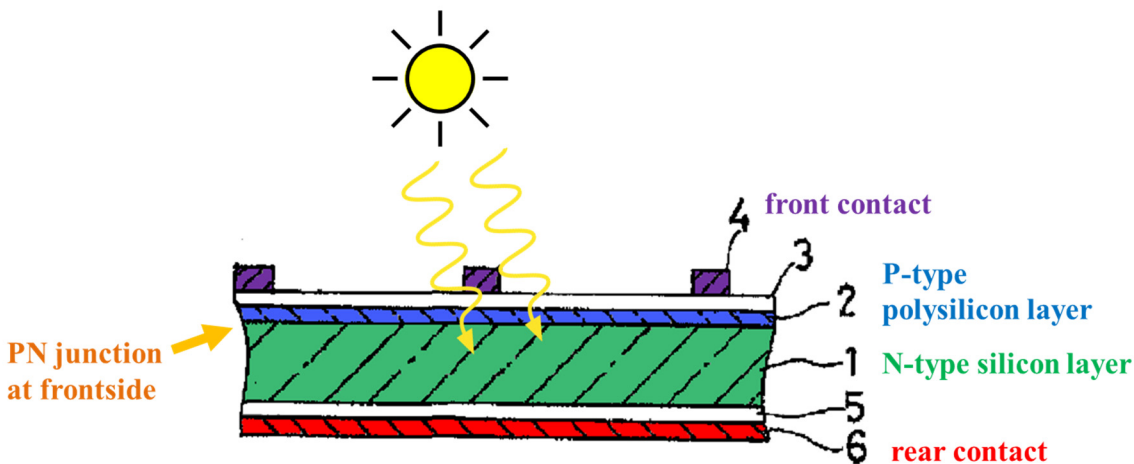
pair in the solar cell. Specifically, photons cause electrons (negative subatomic particles) to leave their bonds, leaving a positively charged “hole.” The separated electrons and holes are mobile and move through the solar cell. The electrons and holes migrate to their respective electrodes, either positive or negative, creating a voltage differential between the n-type and p-type layers and generating the current flow. The PN junction facilitates this movement. Ex.1003-Decl., ¶¶56-57.

An exemplary solar cell is below. It includes an **n-type silicon layer**, which is the thickest layer and known as the “substrate.” It also includes a **p-type layer** on the **silicon layer’s** back side. The PN junction exists at the interface of the n-type and p-type layers, and the layer that is oppositely doped from the substrate is known as the “emitter.”



Ex.1004-Froitzheim, Fig.3.² Ex.1003-Decl., ¶58.

It was well known that the PN junction could be located at the cell's "front side" or "back side." In a backside configuration (above), the **substrate** is closer to the sun such that the PN junction is formed on the **substrate's** backside. Ex.1004-Froitzheim, Fig.1, Fig.3; Ex.1008-Li, Fig.1; Ex.1022-Meier, Fig.2. In a frontside configuration (below), the **emitter** (p-type) would be closer to the sun such that the PN junction is formed on the **substrate's** (n-type) frontside. See Ex.1001-USP053, 1:37-41.



Ex.1031-Okayasu,³ Fig.1. Ex.1003-Decl., ¶¶59-60.

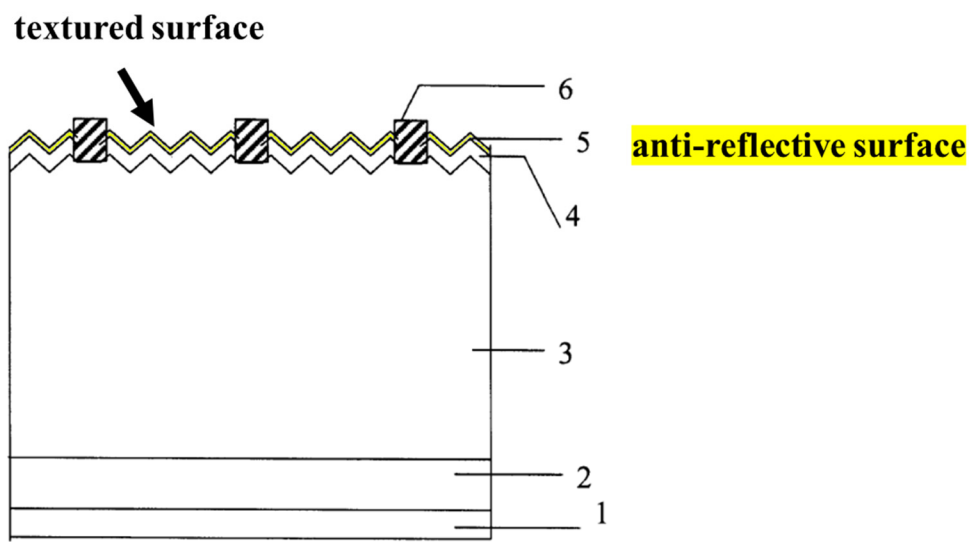
² All annotations and emphasis added unless otherwise noted.

³ See Ex.1032 (translator declaration).

It was well known that backside junctions were advantageous, especially when the cell includes a silicon substrate and polysilicon emitter. The manufacturing process (i.e., layer creation and doping processes) for frontside or backside configurations was similar. Ex.1003-Decl., ¶¶61-65.

It was also well known that solar cells have metal contacts for connecting multiple solar cells together and to external circuits. For example, the solar cells shown above include at least one **front metal contact** and **rear metal contact**. Ex.1003-Decl., ¶¶66-68.

It was further well known that solar cells have textured front surfaces and anti-reflective surfaces (below). Texturing the front of a solar cell helps reflect sunlight into the cell, and adding anti-reflection coatings minimizes the amount of light deflected away from the cell.



Ex.1008-Li, Fig.1; see also Ex.1004-Froitzheim, [0039]. Ex.1003-Decl., ¶¶69-74.

B. Solar Cell Efficiency

POSITAs have worked for decades to improve solar cell efficiency. Solar cells generate electricity through the creation and movement of electron-hole pairs. It was well known that maximizing the number of electrons and holes that exit a cell via the metal contacts improves efficiency. Ex.1003-Decl., ¶¶74-76.

One known way to increase the number of electrons and holes that exit a cell is to prevent the electrons and holes from “recombining” with each other before exiting the cell. This process is known as “recombination,” and when this recombination occurs, the electron-hole pairs no longer contribute to the generated current, thereby reducing the solar cell’s efficiency. It was well known prior to 2008 that recombination occurs at various locations, such as metal contacts and surfaces. Ex.1003-Decl., ¶¶77-79.

A known way to evaluate recombination was to measure the emitter saturation current density (J_o). The emitter saturation current density represents the sum of the different recombination mechanisms that occur at the emitter. Lower emitter saturation current density indicates less recombination and, thus, a more efficient solar cell. Ex.1003-Decl., ¶80.

Various techniques to address recombination existed prior to 2008. For example, it was well known that passivating⁴ the surface of a silicon layer with oxide or nitride reduced recombination losses at that location. Ex.1003-Decl., ¶¶81-84.

Another known way to increase the cell efficiency was to lower “contact resistance.” Contact resistance (ρ_c) exists at the interface between the silicon or polysilicon layer and metal contact and is present in every solar cell. Resistance represents an opposition to current flow, and increased resistance lowers a cell’s power output. POSITAs thus sought designs with lower contact resistance for a more efficient solar cell. Ex.1003-Decl., ¶85.

POSITAs understood that contact resistance and recombination were closely related and how to balance contact resistance and recombination to improve cell efficiency. Ex.1003-Decl., ¶85.

VI. THE ’053 PATENT

A. Brief Description

The ’053 patent is directed to methods for fabricating a solar cell, which before the ’053 patent was a “well known device[] for converting solar radiation to electrical energy.” Ex.1001-USP053, Abstract, 1:21-28, 2:12-14, 3:49-5:18. Its

⁴ “Passivate” refers to preventing recombination. Ex.1003-Decl., ¶¶81-82.

solar cell includes an **N-type substrate 101** that forms a “backside junction” with **P-type emitter 108** on the bottom side of the cell (i.e., side facing away from the sun).⁵ *Id.*, 2:35-43. The **N-type substrate’s** front side may be textured (113) and include an anti-reflective coating (103). *Id.*, 2:42-45, 2:57-59.

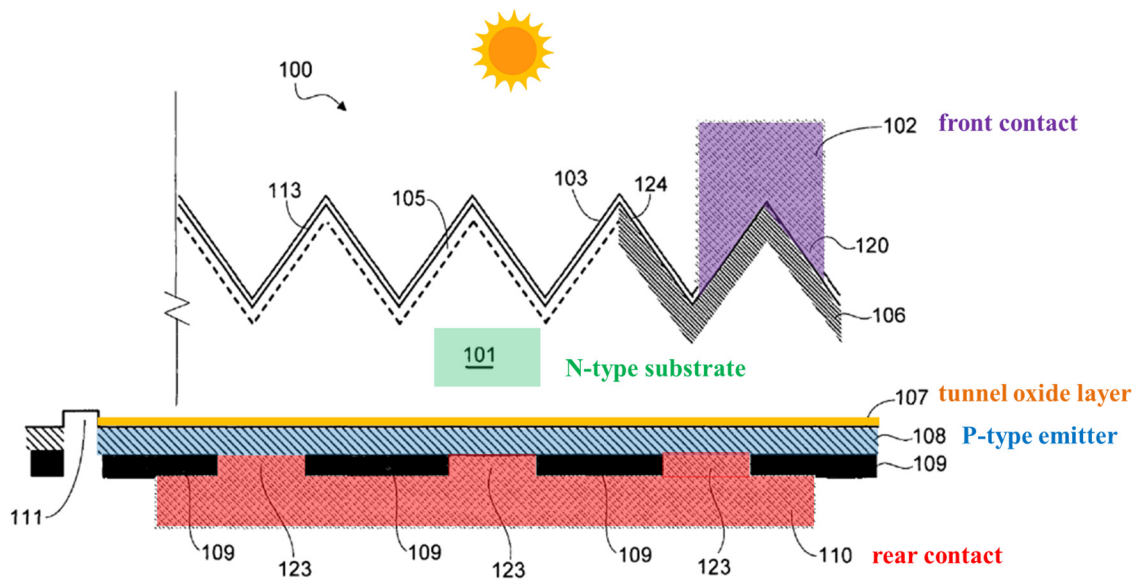


FIG. 1

Id., Fig.1. The solar cell includes two contacts—**metal contact 102** electrically connected to the **N-type substrate** and **metal contact 110** electrically connected to

⁵ The '053 patent's applicant repeatedly represented to the Patent Office that an emitter is oppositely doped from the substrate. *See, e.g.*, Ex.1002-FH053, 217-19; Ex.1039-FH771, 262-268, 279-282, 312-317, 387-392, 416. Ex.1003-Decl., ¶¶93-97, 100-101.

the **P-type emitter**. *Id.*, 3:6-29. The “**metal contact 110** electrically connects to the **polysilicon emitter 108** through contact holes 123 formed through a dielectric comprising a silicon dioxide layer 109.” *Id.*, 3:6-9. Ex.1003-Decl., ¶¶87-88.

The '053 patent explains that a **tunnel oxide layer 107** may be formed between the N-type substrate and P-type emitter. Ex.1001-USP053, 2:64-3:6. It does not explain the purpose or function of the **tunnel oxide layer**. The '053 patent teaches and claims methods of manufacturing these structural features. *Id.*, 1:20-6:10, Figs.1, 4A-4M. Ex.1003-Decl., ¶¶89-91.

B. Prosecution History

Application No. 13/495,577, which issued as the '053 patent and was filed on June 13, 2012, was a divisional application of Application No. 12/070,742, which issued as the '516 patent and was filed on February 20, 2008. Ex.1001-USP053, Cover. Ex.1003-Decl., ¶92.

The examined claims recited “diffusing dopants...to the layer of polysilicon to form a backside junction with the silicon substrate.” Ex.1002-FH053, 5. Throughout prosecution, the applicant argued the cited prior art disclosed a back surface field (“BSF”), as opposed to the recited “backside junction” (i.e., the prior art did not disclose a rear emitter that was oppositely doped from the substrate). *E.g.*, *id.*, 155-56, 217-19, 232-37. The claims incorrectly issued based on the structure

resulting from the recited method steps, and there is no indication the examiner found the recited method steps novel or not obvious. *See id.*, 250 (“The prior art of record lacks the instantly claimed backside junction formed at the interface of a first material of a silicon substrate comprising one dopant type and a second material of a polysilicon layer of an opposite dopant type.”). Ex.1003-Decl., ¶¶93-99.

VII. PERSON OF ORDINARY SKILL IN THE ART

A POSITA at the priority date of the '053 patent (February 20, 2008) would have had (i) an advanced degree in electrical engineering, mechanical engineering, applied physics, chemistry, materials science, or a related discipline and (ii) at least one year of experience designing, developing, or researching the design and/or manufacture of solar cells or related technologies. Alternatively, a POSITA would have had (i) a bachelor's degree in the aforementioned disciplines and (ii) at least two years of experience designing, developing, or researching the design and/or manufacture of solar cells or related technologies. Less work experience may be compensated by a higher level of education, and vice versa. Ex.1003-Decl., ¶¶36-41.

VIII. CLAIM CONSTRUCTION

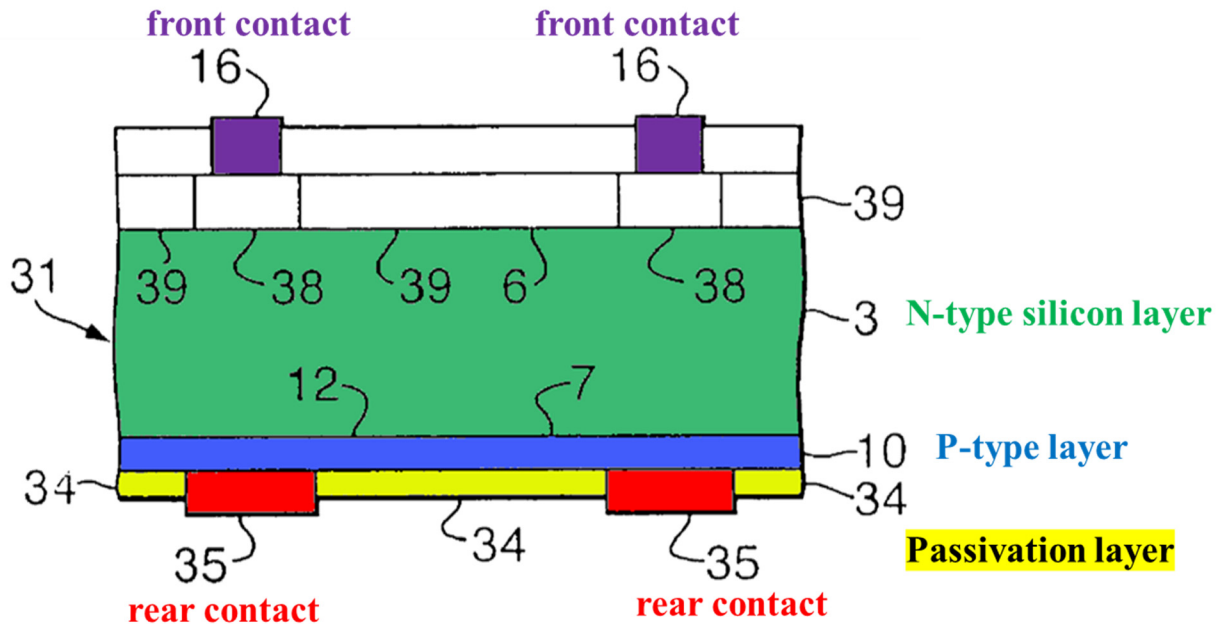
The claims should be given their plain and ordinary meaning to resolve the issues in this proceeding. Ex.1003-Decl., ¶¶102-105.⁶

IX. OVERVIEW OF THE PRIOR ART

A. Froitzheim

Froitzheim, which was not of record, teaches manufacturing a rear junction (i.e., back-junction) solar cell comprising a **silicon body layer** having a front side, which faces the sun, and a back side. Ex.1004-Froitzheim, [0010]-[0011]. Froitzheim's solar cell includes a **p-type layer** that forms a PN junction with the bottom of the **silicon body layer** substrate. *Id.*, [0010]-[0011]. It also includes a backside **passivation layer** that “minimize[s] recombination losses” and is an oxide such as silicon oxide (SiO₂). *Id.*, [0019], [0033]. It further includes **front contacts** electrically connected to the **silicon body layer** and **rear contacts** electrically connected to the **p-type layer**. *Id.*, [0033]-[0034].

⁶ Petitioner reserves the right to propose or respond to claim constructions in parallel litigation and respond to any claim construction PO advances here.



Ex.1004-Froitzheim, Fig.3, [0024]-[0032], Fig.1. Ex.1003-DecI., ¶¶106-107.

Froitzheim teaches that “etching can be used to texture the surface in order to improve the geometry of incidence of light in order to prevent reflection.” Ex.1004-Froitzheim, [0039]. Similarly, Froitzheim teaches that “antireflection coating can be applied using known methods.” *Id.*, [0050]. Ex.1003-DecI., ¶108.

B. Gan

Gan, which was not of record, teaches manufacturing a solar cell structure with a “polysilicon emitter with a thermally grown interfacial oxide” over a silicon substrate. Ex.1005-Gan, 245-246. Gan teaches that solar “cell performance can be improved if [a] diffused-emitter is replaced with [a] polysilicon emitter....” *Id.*, 245. Gan explains that “a very thin oxide (interfacial oxide)” “always exists” between the

“polysilicon [emitter] and the substrate, which can be as a by-product of the cleaning process or is grown intentionally.” *Id.*, 245. Gan specifically evaluates a solar cell structure with a p-type “polysilicon emitter with a thermally grown interfacial oxide” over a silicon substrate. *Id.*, 245-246, 249, Figs.4-5. Ex.1003-Decl., ¶109.

Gan explains that lower recombination (J_o) and contact resistance (ρ_c)—important factors for solar cell efficiency—are achieved when utilizing a polysilicon emitter that includes a thin oxide between the polysilicon emitter and substrate. Ex.1005-Gan, 245; Section V.B. Gan observes “that the J_o of the p-type polysilicon emitter” with a “thermal oxide as the interfacial layer” “appear[ed] to be much lower than [was] previously reported....” Ex.1005-Gan, 248. It also observes that the combination of a polysilicon emitter and thin oxide layer had lower emitter saturation current density (J_o) and contact resistance (ρ_c) as compared to diffused emitters. *Id.*, 249 (“most of J_o are below...about one order magnitude lower than that of diffused-emitters...[and] most of ρ_c are also lower”). Ex.1003-Decl., ¶¶110-111.

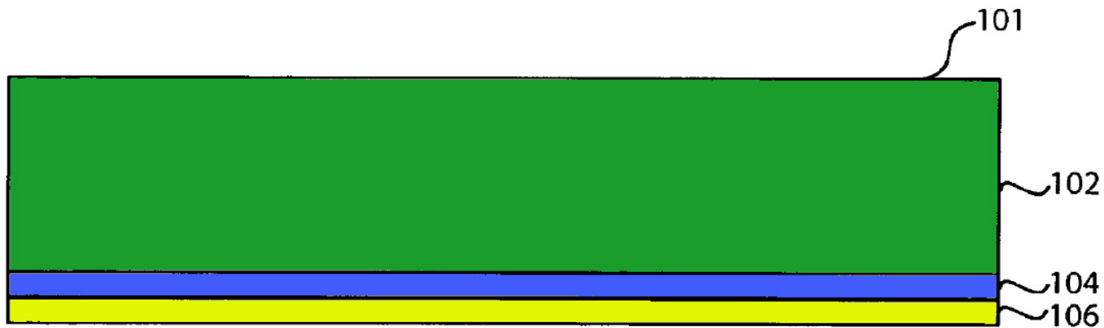
Based on these observations, Gan concludes that polysilicon emitters and interfacial oxide layers are “quite useful for silicon concentrator^[7] solar cells,” and “more than one absolute percent of the cell efficiency is obtained for a **backside contact solar cell** with polysilicon emitters with characteristics shown here.” Ex.1005-Gan, 249. It was well known that “backside contact” solar cells had PN junctions on the cell’s back side. *See, e.g.*, Ex.1015-Swanson, 1:20-26. Ex.1003-Decl., ¶112.

C. Smith

Smith, which was of record, teaches “techniques for simplifying the fabrication of solar cells.” Ex.1007-Smith, 1:36-40, Abstract, Figs.1-7, claims 1-20. Specifically, Smith teaches depositing “**boron-doped silicon dioxide (SiO₂) (‘BSG’)** 104...on the back side of **wafer 102**...using an atmospheric pressure chemical vapor deposition process (APCVD).” *Id.*, 2:44-49. After APCVD, “an **undoped silicon dioxide 106**” layer is deposited. *Id.*, 2:53-60. Using APCVD and

⁷ Concentrator solar cells use lenses, mirrors, or similar structures to concentrate sunlight onto the cell. Ex.1016-Komp, 56-58. Non-concentrator cells do not utilize such features. *Id.* Ex.1003-Decl., ¶112.

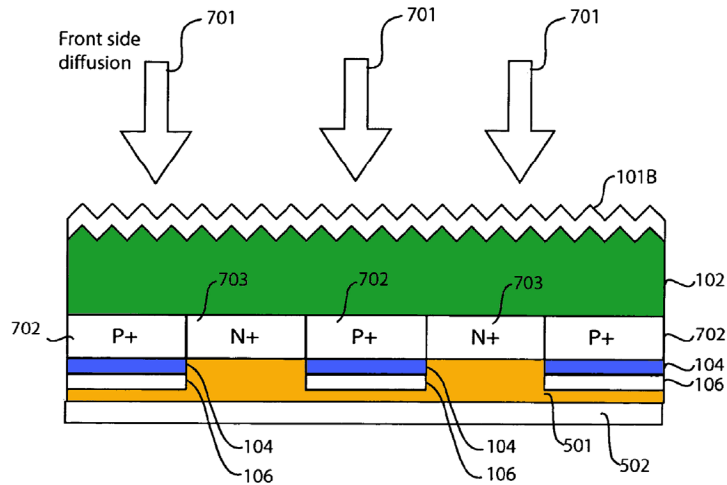
undoped silicon dioxide “advantageously allows for one sided deposition.” *Id.*, 2:55-60.



Id., Fig.2. Ex.1003-Decl., ¶113.

Smith also teaches “in-situ” diffusion, which “simplifies the fabrication process.” Ex.1007-Smith, 3:40-4:2. Smith explains that in-situ diffusion means diffusion steps “are performed in **one loading** of wafer [] into the wafer processing tool.” *Id.*, 3:40-42. Ex.1003-Decl., ¶114.

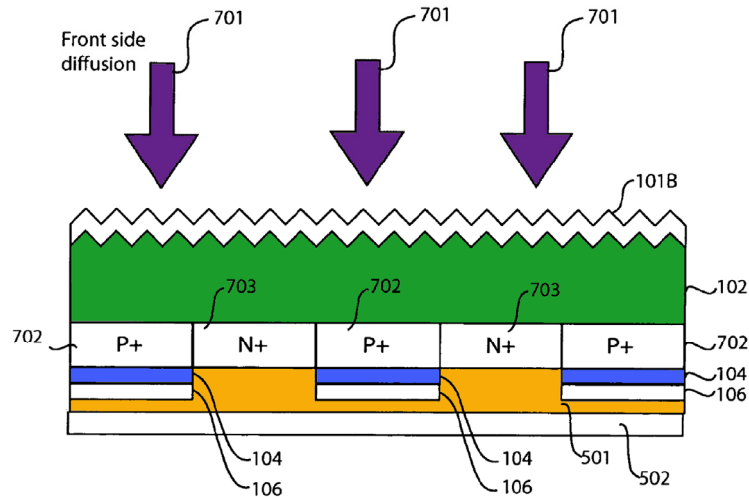
Smith’s in-situ diffusion involves two steps after the wafer is loaded into a furnace. The “first in-situ step” involves diffusing **p-type dopants 104** and **n-type dopants 501** to the back side of the substrate. Ex.1007-Smith, 3:40-55. It teaches the “**wafer 102** is heated to about 1000° C. for one hour to diffuse dopants from **boron-doped silicon dioxide 104** and **phosphorus-doped silicon dioxide 501** into **wafer 102**.” *Id.*



Ex.1007-Smith, Fig.7. Ex.1003-Decl., ¶115.

The “second in-situ step” involves “changing [the finance conditions] to...diffuse phosphorus as an N-type dopant into wafer 102 from its front side.”

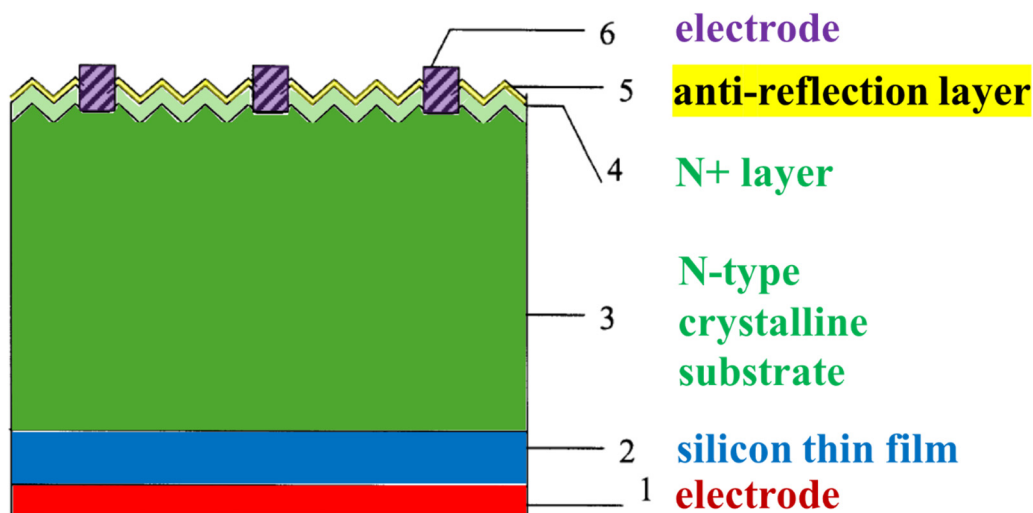
Id., 3:56-67.



Id., Fig.4, claims 1-2, 9, 10, 20. Ex.1003-Decl., ¶116.

D. Li

Li, which was not of record, teaches manufacturing a solar cell with an emitting region over the substrate's back surface. Ex.1008-Li, 2. Li's solar cell includes a back **electrode 1**, **silicon thin film 2**, **N-type silicon substrate 3**, **highly doped N+ layer 4**, **anti-reflection layer 5**, and **electrode 6**. *Id.*, Abstract, 2. Li's **silicon thin film** is prepared by deposition and is amorphous silicon, microcrystalline silicon, or nanocrystalline silicon. *Id.*, 2. The **anti-reflection layer** is either SiN (silicon nitride) or SiO₂ (silicon dioxide). *Id.* The **highly doped N+ layer** is used "for passivating the front surface of a cell by using changes in doping concentration and for providing good ohmic contact to a front surface electrode." *Id.*, 4.



Id., Fig.1. Li’s teachings are directed to balancing increased cell efficiency and decreased manufacturing costs. *Id.*, 2-4. Ex.1003-Decl., ¶¶117-119.

X. SPECIFIC GROUNDS FOR UNPATENTABILITY

Pursuant to Rule 42.104(b)(4)-(5), and as confirmed in Dr. Holman’s declaration (Ex.1003), the prior art renders obvious every element of the Challenged Claims.⁸

A. Ground I: Claims 9-12, 14, and 16-20 Are Invalid as Obvious over Froitzheim and Gan

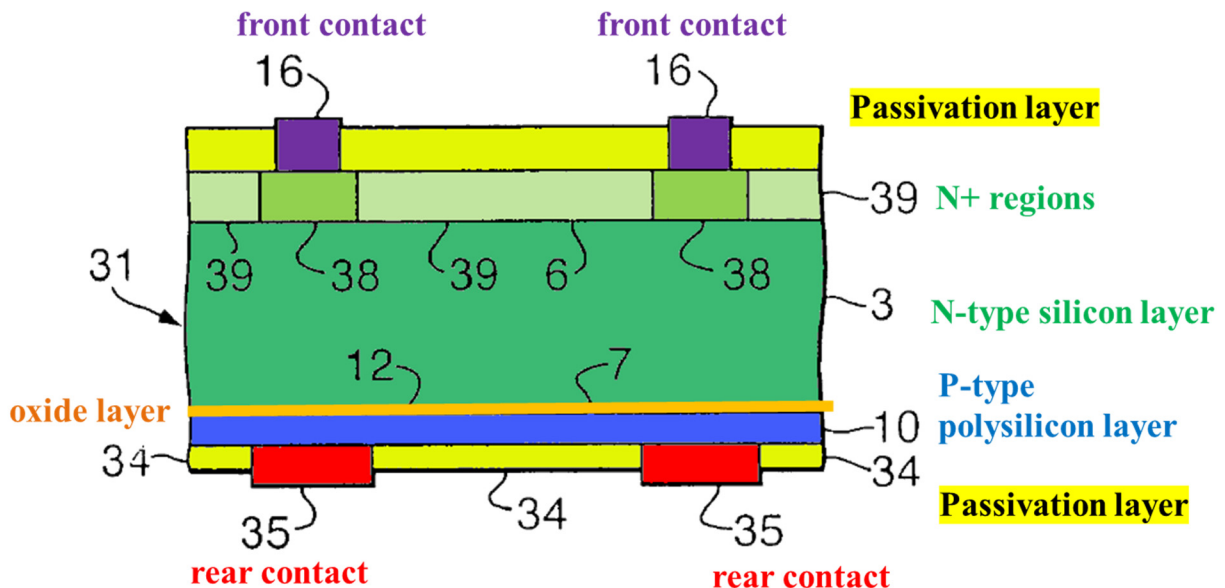
1. Motivation to Combine

Obviousness requires that (1) the references in a combination “are analogous to the claims being challenged,” and that (2) a POSITA would have been motivated to combine the references (3) with a reasonable expectation of success. *See Corephotonics, Ltd. v. Apple Inc.*, 84 F.4th 990, 1004 (Fed. Cir. 2023). Each requirement is met here. Ex.1003-Decl., ¶121.

The combination of Froitzheim’s fabrication of a back-junction solar cell and Gan’s fabrication of a polysilicon emitter and oxide layer amounts to use of a known

⁸ Any attempt by PO to rely on alleged secondary considerations of nonobviousness cannot overcome the showing of obviousness detailed herein. Ex.1003-Decl., ¶336; *Tokai Corp. v. Easton Enters., Inc.*, 632 F.3d 1358, 1371 (Fed. Cir. 2011).

feature (Gan's polysilicon emitter and oxide layer) to improve a similar device (Froitzheim's back-junction solar cell) to achieve goals common to both references and the industry (increasing efficiency). As detailed below, a POSITA would have been motivated to modify Froitzheim's manufacturing methods of making a back-junction solar cell to implement Gan's methods of making a polysilicon emitter and oxide layer:



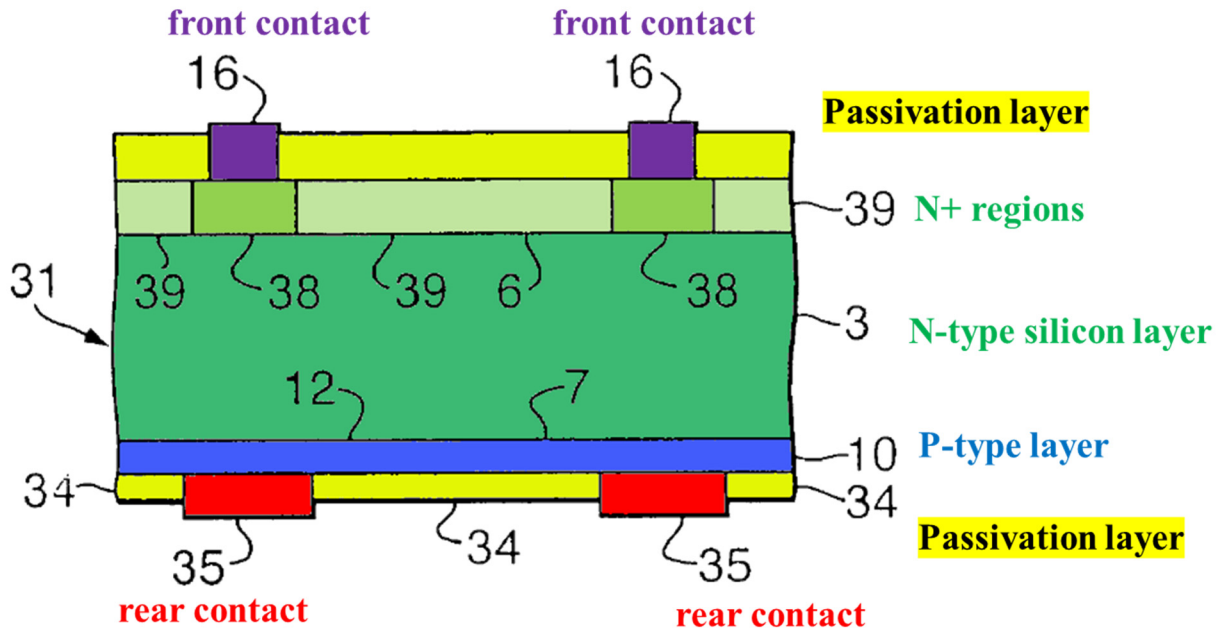
Ex.1004-Froitzheim, Fig.3; Ex.1005-Gan, 245, 249. Ex.1003-Decl., ¶122.

Analogous Art: Froitzheim and Gan are analogous art to the Challenged Claims. Both are in the same field as the Challenged Claims (fabricating solar cells) and are reasonably pertinent to solving the problems addressed in the Challenged Claims (increasing efficiency) with the same types of solutions (optimizing solar cell

fabrication and resulting configuration). Ex.1004-Froitzheim, [0001]-[0009]; Ex.1005-Gan, 245-249. Ex.1003-Decl., ¶123.

Motivation to Combine: A POSITA would have been motivated to implement manufacturing steps to incorporate Gan's oxide layer and polysilicon emitter in Froitzheim's solar cell to obtain a more efficient solar cell. Ex.1003-Decl., ¶124.

Froitzheim and Gan teach fabricating solar cell structures that are directed to improving a cell's efficiency. Froitzheim teaches improving a cell's efficiency by utilizing a back-junction solar cell and addressing recombination at the silicon wafer surfaces. Froitzheim teaches fabricating a "rear junction solar cell" that includes an **n-type silicon layer** and **p-type emitter** that form a backside PN junction. Ex.1004-Froitzheim, [0010]-[0011], Fig.3. Froitzheim also teaches forming **passivation layers** to reduce recombination losses at the silicon layer's surfaces. *Id.*, [0010]-[0011], [0017]-[0021].



Ex.1004-Froitzheim, Fig.3. Froitzheim explains this configuration demonstrated “improved stability and good efficiency.” *Id.*, [0009]. Ex.1003-Decl., ¶¶125-126.

A POSITA would have been motivated to further improve the efficiency of Froitzheim’s solar cell by including fabrication steps to incorporate Gan’s polysilicon emitter and oxide layer. Gan teaches that a solar cell’s “performance can be improved if [a] **diffused-emitter** [(like Froitzheim’s diffused-emitter)] **is replaced with [a] polysilicon emitter.**” Ex.1005-Gan, 245. As discussed in Section IX.B, Gan analyzes a solar cell structure with an **oxide layer** between a **polysilicon emitter** and **silicon substrate** and evaluates the emitter saturation current density (J_o) and contact resistance (ρ_c) for this structure. *Id.*, 245-246. Emitter saturation current density is indicative of recombination, and reducing recombination increases

solar cell efficiency. Section V.B. Contact resistance is indicative of how much power is lost at a barrier between two components, and a lower contact resistance increases solar cell efficiency. *Id.* Ex.1003-Decl., ¶¶127-128.

Gan's published data demonstrates a polysilicon emitter and oxide layer structure would have improved performance over a diffused emitter. Gan's Figure 6 (below) reports the contact resistance (ρ_c) and emitter saturation current density (J_o) data for the studied polysilicon emitter and oxide layer structure. Gan observes "that the J_o of the p-type polysilicon emitter" with a "thermal oxide as the interfacial layer" was "much lower than [was] previously reported." Ex.1005-Gan, 248. Gan also observes that the combination of a polysilicon emitter and oxide layer structure had lower recombination and contact resistance as compared to diffused-emitters. *Id.*, 249.

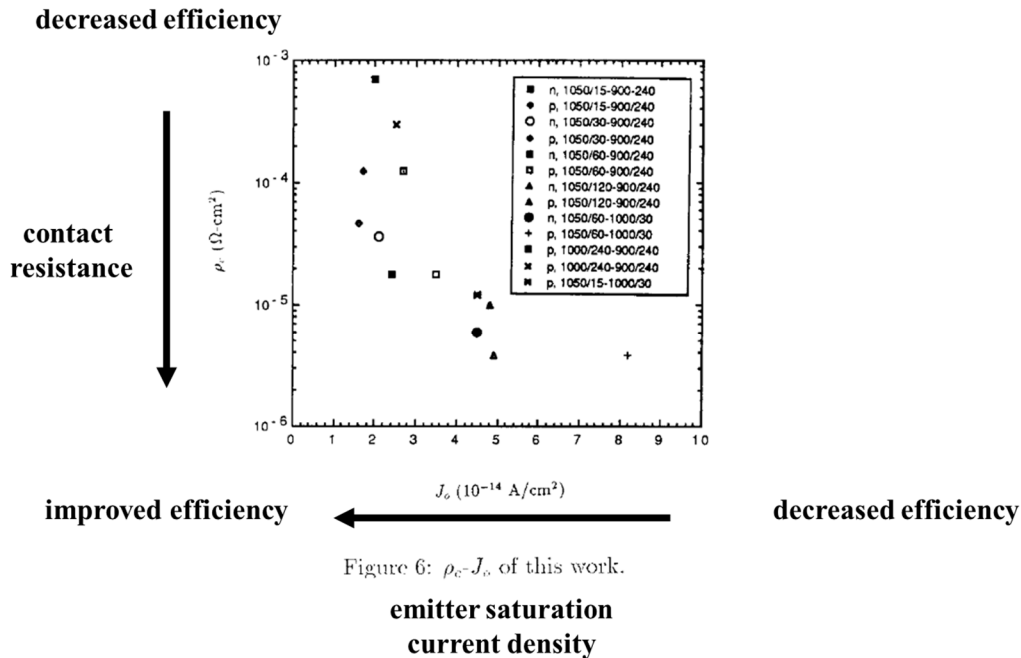


Figure 6: ρ_c - J_o of this work.

Ex.1005-Gan, Fig.6. Based on this data, Gan concludes that a polysilicon emitter and oxide layer structure is “quite useful for silicon solar cells.”⁹ *Id.*, 249; *see also id.* (“polysilicon emitters with low J_o and ρ_c can be obtained with a very small fraction of interfacial oxide breakup.”). Ex.1003-Decl., ¶129.

⁹ Although Gan references “concentrator” solar cells, Gan’s teachings are nonetheless relevant for non-concentrator solar cells. Indeed, Gan broadly suggests that its polysilicon emitter and oxide layer structure are generally “useful for silicon solar cells,” and a POSITA would have understood that the benefits Gan teaches are equally applicable to non-concentrator solar cells. Ex.1005-Gan, 249. Ex.1003-Decl., ¶131.

In view of Gan’s teachings, a POSITA would have been motivated to modify Froitzheim’s solar cell to incorporate a polysilicon emitter and oxide layer structure to obtain a more efficient solar cell. Gan specifically teaches that replacing a diffused emitter (as taught by Froitzheim) with a polysilicon emitter and oxide layer structure would improve the efficiency of a solar cell. Ex.1005-Gan, 249. Gan also explains that its teachings are directly applicable to p-type emitters and silicon substrates, just like the p-type emitter and silicon substrate taught in Froitzheim. *Id.*, 246, 248-249; Ex.1004-Froitzheim, [0010]-[0011]. Ex.1003-Decl., ¶130.

Notably, Gan also teaches that its structure is useful for solar cells that have backside PN junctions like Froitzheim. Ex.1005-Gan, 249. Gan indicates that this structure on “backside contact solar cells” would achieve an improvement of “more than one absolute percent of the cell efficiency....” *Id.* As discussed above, it was well known that “backside contact” solar cells included cells with PN junctions on the cell’s back side. *See, e.g.*, Ex.1015-Swanson, 1:20-26. Thus, a POSITA would have understood that replacing Froitzheim’s diffused emitter with a polysilicon emitter and oxide layer structure as taught by Gan was simply applying a known technique to a similar device ready for improvement to yield predictable results. *KSR Int’l Co. v. Teleflex Inc.*, 550 U.S. 398, 417 (2007); *Tokai*, 632 F.3d at 1372

(finding obviousness because limitation was “nothing more than a **predictable variation**”). Ex.1003-Decl., ¶132.

Moreover, a POSITA would have been motivated to retain fabrication steps that resulted in Froitzheim’s back-junction solar cell design. For example, Froitzheim teaches that a backside emitter is beneficial because it reduces the amount of light absorbed by the emitter. Ex.1004-Froitzheim, [0013]. When light is absorbed by the emitter, the amount of electricity that can be produced by the cell decreases. A POSITA would have also understood that a polysilicon emitter would absorb light that would otherwise enter the active region of a cell that generates electron-hole pairs. That is, a frontside polysilicon emitter would absorb light that would otherwise contribute to generating electricity and thereby decrease the cell’s efficiency. *E.g.*, Ex.1062-Farrokh-Baroughi, 5-6; Ex.1059-Lubberts, 6877. Thus, a POSITA would have understood that Froitzheim’s backside configuration would be improved by implementing Gan’s polysilicon emitter and would account for the potential drawbacks of a polysilicon emitter (absorption). Ex.1003-Decl., ¶¶133-134.

A POSITA would have also been motivated to fabricate a solar cell having a polysilicon emitter and oxide layer structure as taught by Gan in Froitzheim’s solar cell because Froitzheim and Gan teach fabricating similar and compatible solar cells.

Each reference teaches the same basic configuration of a substrate, p-type emitter, PN junction, and contacts, made by similar processes. Ex.1004-Froitzheim, [0010]-[0011], [0042] (doping at 900-1200 °C); Ex.1005-Gan, 246 (doping at 900-1000°C). A POSITA would have thus realized that Froitzheim and Gan have compatible manufacturing processes because new equipment—e.g., a furnace for diffusion—would not be required. Ex.1003-Decl., ¶135.

A POSITA would have also been motivated to fabricate a solar cell with a polysilicon emitter and oxide structure in Froitzheim because doing so was simply substituting one known element for another to obtain predictable results. For example, a POSITA would have understood how to add oxide layers to silicon surfaces and manufacture a polysilicon emitter, as doing so was well known and routine by 2008. Ex.1005-Gan, 246; Ex.1006-Borden-575, [0026]-[0027]; Ex.1004-Froitzheim, [0030]; Ex.1015-Swanson, 2:50-53. Indeed, the '053 patent assumes that a POSITA would have understood how to manufacture these layers, as it describes them without specific implementation details. *Uber Techs., Inc. v. X One, Inc.*, 957 F.3d 1334, 1339 (Fed. Cir. 2020) (specification's silence “suggest[s] that a [POSITA] was more than capable of selecting between the known methods”). Ex.1003-Decl., ¶136.

Additionally, a POSITA would have understood that implementing a polysilicon emitter and oxide structure in Froitzheim was a simple design choice. *Medichem, S.A. v. Rolabo, S.L.*, 437 F.3d 1157, 1165 (Fed. Cir. 2006); *In re Urbanski*, 809 F.3d 1237, 1243-44 (Fed. Cir. 2016). Even if additional manufacturing steps or components were needed to modify Froitzheim's solar cell to implement Gan's polysilicon emitter and oxide layer, a POSITA would have nonetheless been motivated to do so to achieve a higher efficiency cell. Given the importance of a solar cell's efficiency, a POSITA would have been motivated to incur modest costs to improve efficiency. Ex.1003-Decl., ¶137.

Finally, a POSITA would have understood that numerous prior art references similarly teach the benefits of using an oxide layer with a polysilicon emitter. Ex.1006-Borden-575, [0016], [0022]; Ex.1034-Rahim; Ex.1046-Kwark, 1125; Ex.1023-Yablonovitch, 3:61-64. For example, Foglietti teaches that an interfacial oxide minimizes recombination and increases transistor gain, and that the result is predictable. Ex.1042-Foglietti, [0046]; Ex.1039-FH771, 463 (Board affirming findings on Foglietti's teachings). Thus, a POSITA would have understood the combination of Froitzheim and Gan was simply using known techniques to improve similar devices in the same way. Ex.1003-Decl., ¶¶138-141.

Reasonable Expectation of Success: A POSITA would have had a reasonable expectation of successfully modifying Froitzheim's fabrication methods to incorporate Gan's methods of using a polysilicon emitter and oxide layer. Gan teaches how to incorporate an oxide layer and polysilicon emitter, and including such layers was well known in the art. Ex.1005-Gan, 246; Ex.1006-Borden-575, [0022]; Ex.1046-Kwark, Abstract, 1121. A POSITA would have thus understood that modifying Froitzheim to include Gan's polysilicon emitter and oxide layer was simply substituting one known element (polysilicon emitter and oxide layer structure) for another (diffused-emitter) to obtain the predictable result of a more efficient cell. *KSR*, 550 U.S. at 417; *Tokai*, 632 F.3d at 1372. Ex.1003-Dec1., ¶142.

Moreover, Gan and Froitzheim teach thermal drive-in diffusion processes and overlapping temperature ranges. Ex.1004-Froitzheim, [0042]; Ex.1005-Gan, 246. A POSITA would have thus appreciated the references have compatible manufacturing steps. Ex.1003-Dec1., ¶143.

A POSITA would have also readily understood how to replace a diffused emitter with a polysilicon emitter and oxide layer. A POSITA would have understood that instead of diffusing boron into the substrate's back side as taught by Froitzheim, a POSITA would instead follow the manufacturing technique taught by Gan. That is, a POSITA would have grown an interfacial oxide layer on the

substrate's back side, created a polysilicon layer over the oxide layer on the substrate's back side, and then doped the polysilicon layer instead of the substrate to form the polysilicon emitter. Ex.1005-Gan, 246. These well-known and routine steps were well within a POSITA's skillset. Indeed, the '053 patent assumes a POSITA would have understood how to manufacture the modified solar cell. Ex.1001-USP053, 3:40-6:2; *Uber*, 957 F.3d at 1339. This further demonstrates that modifying Froitzheim in view of Gan simply involves using Gan's known technique of a polysilicon emitter and oxide layer with Froitzheim's known solar cell to improve Froitzheim's solar cell in a similar way. Ex.1003-Decl., ¶144.

A POSITA would also have further reasonably expected success because tunnel oxide layers and polysilicon emitters had been successfully implemented in multiple instances. Ex.1005-Gan, 246; Ex.1006-Borden-575, [0022]; Ex.1046-Kwark, Abstract, 1121. For example, a POSITA would have expected that Gan's teachings of adopting a known, successful technique for transistors to solar cells would likewise succeed when applied to Froitzheim's backside solar cell configuration. Ex.1003-Decl., ¶145.

2. Claim 9

a. 9[pre]

Froitzheim teaches *a method of fabricating a solar cell*. Ex.1004-Froitzheim, Title, Abstract, [0022], [0024], [0038] (teaching a “method of manufacturing a solar cell”), Fig.1, Fig.3, claims 1-11. Ex.1003-Decl., ¶146.

Gan also teaches *a method of fabricating a structure for a solar cell*. Specifically, Gan teaches a twelve-step “process sequence:”

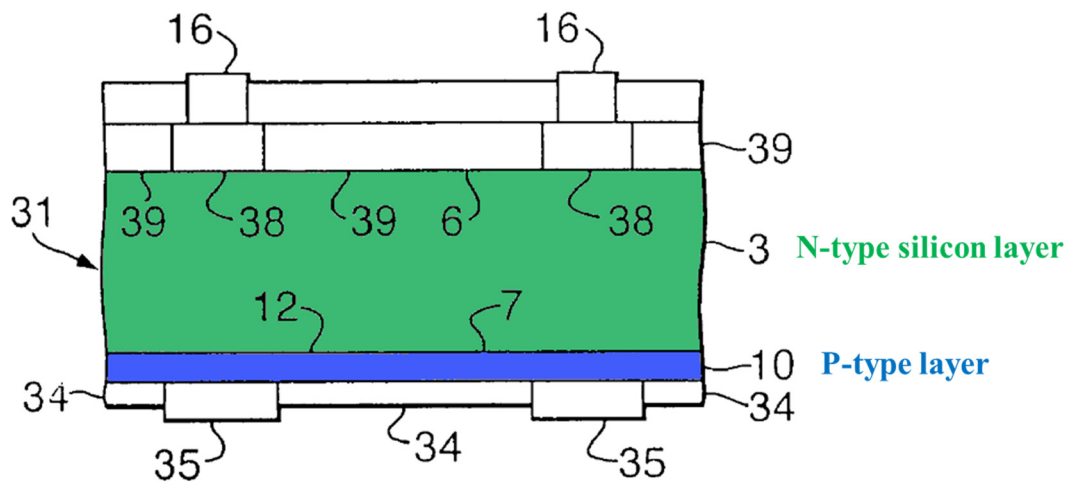
1. Field oxidation (2000 Å)*.
2. Polysilicon-substrate contact opening*.
3. Thin thermal oxide growth at 800 °C*. (10-minute oxygen flow)
4. Polysilicon deposition (6000 Å) and first-step anneal (1050 °C)*.
5. First-step anneal *.
6. Polysilicon finger definition.
7. Undoped glass deposition (2000 Å).
8. Metal-polysilicon and metal-substrate contact opening.
9. Doped glass deposition on both sides of the wafer*.
10. Drive-in; 900-1000 °C*.
11. Doped glass stripping and Al-1% Si alloy deposition.
12. Metal finger definition.

Ex.1005-Gan, 246, 245-249. Ex.1003-Decl., ¶147.

b. 9[a]

The combination of Froitzheim and Gan teaches *forming a layer of polysilicon over a back surface of a silicon substrate*. Froitzheim teaches that “by arranging [i.e., *forming*] a non-alloyed **p-type doped region** at the rear side [i.e., *back surface*]

of an **n-type Silicon body layer** [i.e., **silicon substrate**], a rear junction solar cell is obtained.” Ex.1004-Froitzheim, [0011], [0038]-[0048]. A POSITA would have understood the **p-type doped region**, oppositely doped from the **n-type silicon layer**, is an emitter because it forms “a p/n-junction” with the **n-type silicon layer**. *Id.*, Abstract, [0024]-[0026], claim 1.



Ex.1004-Froitzheim, Fig.3, [0033], Fig.1. Froitzheim thus teaches a **p-type doped emitter** on the *back surface* of an **n-type silicon substrate**. Ex.1003-Decl., ¶¶148-149.

Gan teaches *forming a layer of polysilicon* by a “[p]olysilicon deposition” step. Ex.1005-Gan, 246 (step four). This polysilicon layer becomes a **P-type polysilicon emitter** in subsequent steps and forms a junction with a **silicon substrate**. *Id.*, 245-246. Gan also teaches replacing a diffused emitter (as in

Froitzheim) with a **P-type polysilicon emitter**. Ex.1005-Gan, 245-246. Ex.1003-Decl., ¶¶150-151.

As discussed in Section X.A.1, a POSITA would have been motivated to modify Froitzheim to incorporate a **P-type polysilicon emitter** as taught by Gan with a reasonable expectation of success, which would involve *forming a layer of polysilicon* over the backside of Froitzheim’s **silicon substrate**. Ex.1003-Decl., ¶¶152.

c. 9[b]

The combination of Froitzheim and Gan teaches *forming a first dopant source layer over the layer of polysilicon*. Froitzheim teaches that “a diffusion source layer [i.e., *a first dopant source layer*] that contains boron as a dopant is applied [i.e., *forming*], e.g. spun, only onto the back of the **n-doped silicon wafer**.” Ex.1004-Froitzheim, [0040]-[0041], Fig.3. Froitzheim explains that this process creates the **p-doped layer** (*i.e.*, diffused **emitter**). *Id.*, [0022]. Ex.1003-Decl., ¶¶153-154.

Gan further teaches *forming a first dopant source layer over the layer of polysilicon*. As explained in Section X.A.2.b, step 4 of Gan’s twelve-step “process sequence” deposits the “[p]olysilicon” on the substrate, and step 9 deposits “[d]oped glass” (*i.e.*, *forming a first dopant source layer*) on “both sides of the wafer” (*i.e.*,

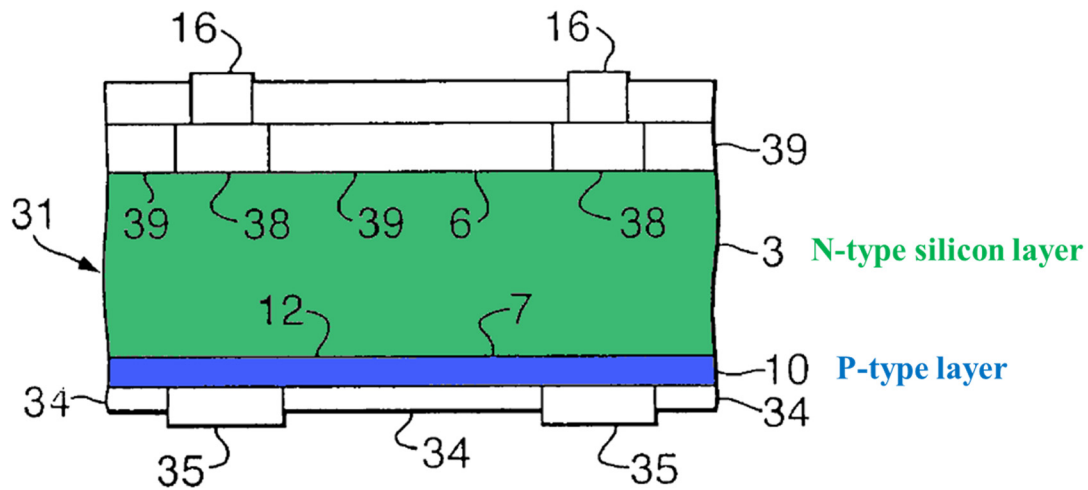
over a layer of polysilicon), which contains p-type dopants that create a “p-type polysilicon emitter” in step 10. Ex.1005-Gan, 246, 248. Ex.1003-Decl., ¶155.

As discussed in Section X.A.1, a POSITA would have been motivated to modify Froitzheim to implement a **P-type polysilicon emitter** as taught by Gan with a reasonable expectation of success, which would involve *forming a dopant source layer* over the *layer of polysilicon* that is formed over the backside of Froitzheim’s **silicon substrate**. Ex.1003-Decl., ¶156.

d. 9[c]

The combination of Froitzheim and Gan teaches *diffusing dopants from the first dopant source layer to the layer of polysilicon to form a backside junction with the silicon substrate*. Ex.1003-Decl., ¶157.

Froitzheim teaches manufacturing an emitter that *forms a backside junction with the silicon substrate*. Froitzheim teaches manufacturing a “rear junction solar cell” that contains a diffused “**p-doped layer 10**” on the rear side of the **n-type silicon layer 3** to form a “p/n-junction.” Ex.1004-Froitzheim, [0025], Abstract, [0010]-[0013], [0024], Fig.1, Fig.3. A POSITA would have understood the diffused **p-type doped region** is the emitter as it is oppositely doped and forms a “p/n-junction” with the **n-type silicon layer**. *Id.*, Abstract, [0024]-[0026], claim 1.



Ex.1004-Froitzheim, Fig.3, [0033], Fig.1. The '053 patent also explains that a “backside junction” exists when an emitter is located on the back side of the solar cell and is oppositely doped from the substrate. Ex.1001-USP053, 1:53-55. Thus, because Froitzheim teaches a **P-type layer** on the back side of an **n-type silicon layer** to create a rear “p/n” junction, Froitzheim teaches *forming a backside junction with the silicon substrate*. Ex.1003-Decl., ¶¶158-159.

To make this configuration, Froitzheim teaches *diffusing dopants from a first dopant source layer* onto the back of the **n-doped silicon wafer** (i.e., *substrate*). Froitzheim teaches that after depositing the “diffusion source layer,” it “**driv[es] in the dopant.**” Ex.1004-Froitzheim, [0041]-[0042]. A POSITA would have understood “drive in the dopant” mean diffusing dopants from the *source layer* to the target layer (i.e., *substrate*), making the emitter. Ex.1003-Decl., ¶160.

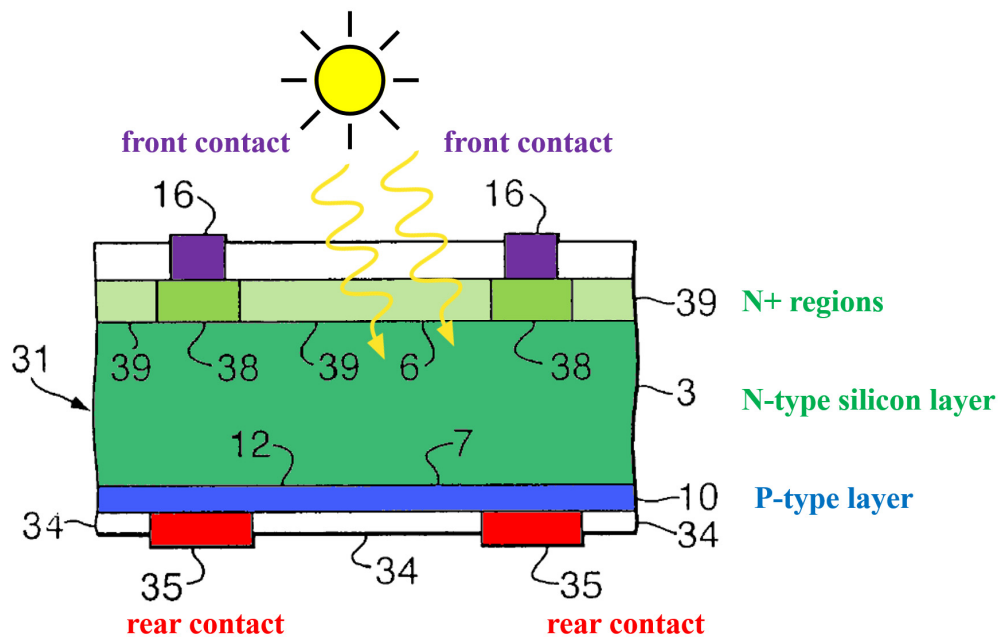
Gan teaches driving-in dopants from *a first dopant source layer to the layer of polysilicon*. Gan teaches that after the doped glass is deposited on the layer of polysilicon (step 9), dopants from the doped glass are “[d]rive[n]-in [at] 900-1000 °C” (step 10) to the target layer (i.e., *polysilicon*). Ex.1005-Gan, 246. A POSITA would have understood that “driv[ing]-in” in Gan also meant diffusing dopants from the doped glass to the layer of polysilicon. *Id.*, 246. Ex.1003-Decl., ¶161.

As discussed in Section X.A.1, a POSITA would have been motivated to modify Froitzheim to implement a **P-type polysilicon emitter** as taught by Gan with a reasonable expectation of success, which would involve diffusing dopants from the source layer to the polysilicon layer *to form a backside junction with the silicon substrate*. Ex.1003-Decl., ¶162.

e. 9[d]

Froitzheim teaches *diffusing dopants into a front surface of the silicon substrate, the front surface of the silicon substrate facing the sun during normal operation*. Froitzheim teaches fabricating a solar cell that has a front and rear side opposite one another. Ex.1004-Froitzheim, Abstract, [0024], [0032]-[0033], Fig.1, Fig. 3, claim 1. Froitzheim explains that “[d]uring normal operation of the solar cell 1 the front side 6 faces the sun.” *Id.*, [0032]. Ex.1003-Decl., ¶¶163-164.

Froitzheim teaches *diffusing dopants into a front surface of the silicon substrate*. Froitzheim teaches “*diffus[ing] [] Phosphorous* from the gas phase to form a frontside **n+ layer**.” Ex.1004-Froitzheim, [0043]-[0044]. Therefore, Froitzheim teaches diffusing phosphorous, a well-known dopant, into the sun-facing, front surface of the silicon substrate (**N-type silicon layer**) to form **N+ regions**:

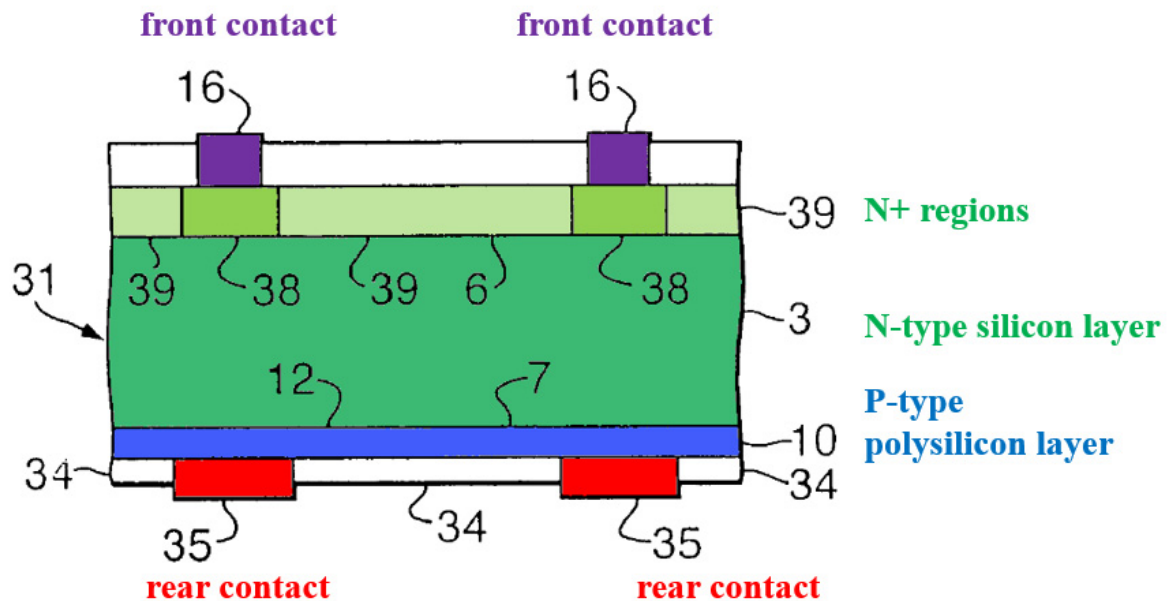


Ex.1004-Froitzheim, Fig.3. Ex.1003-Decl., ¶165.

f. 9[e]

Froitzheim teaches *forming a metal contact on the front surface of the silicon substrate, wherein the metal contact is electrically coupled to the silicon substrate*. Froitzheim teaches screen-printed metal **front contacts 16** (i.e., *forming a metal*

contact) on the **n+ regions**, which is a portion of the **n-type silicon body layer** (i.e., on the front surface of the silicon substrate). Ex.1004-Froitzheim, [0015]-[0018], [0022]. Froitzheim teaches the front contacts are *electrically coupled* to the **n-type silicon body layer** through **n+ doped layer 38 (lighter green)**. *Id.*, [0016] (n+ doped region obtains “a better electrical connection”). A POSITA would have understood the **front contacts** were *metal contacts* because Froitzheim explains the paste for the *contacts* contained silver particles and aluminum, and it was known that screen-printed contacts were made from metal paste. Ex.1004-Froitzheim, [0020], [0049]; Ex.1045-Green-1995, 234-39.



Ex.1004-Froitzheim, Fig.3. Ex.1003-Decl., ¶¶166-168.

Accordingly, the combination of Froitzheim and Gan renders claim 9 obvious.
Ex.1003-Decl., ¶169.

3. Claim 10

Claim 10 depends from claim 9. Petitioner incorporates Section X.A.2. As described in Section X.A.2, the combination of Froitzheim and Gan teaches *the first dopant source layer comprises P-type dopants*. Section X.A.2.b-c (“p-doped layer,” “p-type polysilicon emitter”). Ex.1003-Decl., ¶170.

4. Claim 11

Claim 11 depends from claim 9. Petitioner incorporates Section X.A.2. The combination of Froitzheim and Gan further teaches *the first dopant source layer comprises borosilicate glass*. Froitzheim teaches the first “diffusion source layer that contains boron as [a P-type] dopant is applied, e.g. spun, only onto the back of the n- doped silicon wafer...out of which the boron is thermally driven.” Ex.1004-Froitzheim, [0041]. A POSITA would have understood that boron layer “spun” onto silicon forms *borosilicate glass*. *Id.*, [0041]. In other words, Froitzheim’s diffusion source layer (i.e., *the first dopant source layer*) *comprises borosilicate glass*. Ex.1003-Decl., ¶¶171-173.

A POSITA would have also understood that Gan also teaches *the first dopant source layer comprises borosilicate glass*. As explained in Section X.A.2.c, Gan

teaches forming a first dopant source layer by “[d]oped **glass** deposition” to make a “p-type polysilicon emitter.” Ex.1005-Gan, 246-48. A POSITA would have understood boron was a common p-type dopant source that forms borosilicate glass when deposited on silicon. Ex.1003-Decl., ¶174.

As discussed in Section X.A.1, a POSITA would have been motivated to modify Froitzheim to implement a **P-type polysilicon emitter** as taught by Gan with a reasonable expectation of success, which would involve forming *a dopant source layer that comprises borosilicate glass* to dope the polysilicon layer. Ex.1003-Decl., ¶175.

5. Claim 12

Claim 12 depends from claim 9. Petitioner incorporates Section X.A.2. The combination of Froitzheim and Gan teaches *diffusing dopants into the front surface of the silicon substrate comprises forming a second dopant source layer over the silicon substrate and diffusing dopants from the second dopant source layer into the silicon substrate*. Froitzheim teaches diffusing phosphorous gas over **N-type silicon layer** to create **N+ regions** on the substrate’s front side (*i.e., diffusing dopants into the front surface of the silicon substrate*). See Section X.A.2.e; Ex.1004-Froitzheim, [0044]. “Diffusion of Phosphorous from the gas phase” was widely known as POCl_3 diffusion before 2008 and involved (1) forming a layer of glass with phosphorous

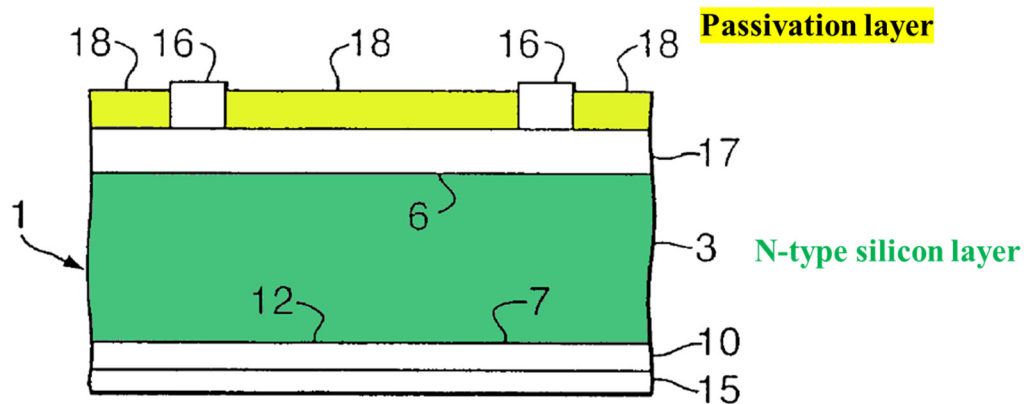
dopants at the silicon surface (*i.e.*, *forming a second dopant source layer over the silicon substrate*), and (2) diffusing phosphorous dopants from the glass layer into the silicon substrate (*i.e.*, *diffusing dopants from the second dopant source layer into the silicon substrate*). *E.g.*, Ex.1052-Avery, 1:19-31 (1979 patent explaining POCl_3 diffusion). Thus, Froitzheim teaches this element. Ex.1003-Decl., ¶¶176-179.

6. Claim 14

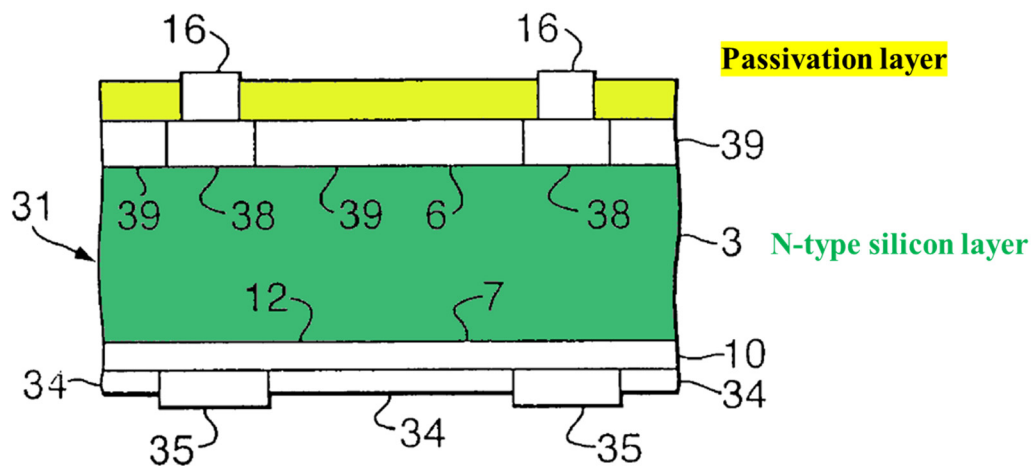
Claim 14 depends from claim 9. Petitioner incorporates Section X.A.2. Froitzheim teaches *texturing the front surface of the silicon substrate[] and forming an antireflective layer over the textured front surface of the silicon substrate*. Froitzheim teaches that “etching can be used to **texture the surface [of the n-type silicon layer (silicon substrate)]** in order to improve the geometry of incidence of light in order to prevent reflection.” Ex.1004-Froitzheim, [0039], [0023], [0056] (“[T]exture etching was applied....”), [0087]. Ex.1003-Decl., ¶¶180-181.

Froitzheim further teaches forming a **passivation layer** with silicon nitride (SiN) on the solar cell’s top side. Ex.1004-Froitzheim, [0030], [0019], [0023], claim 7. Froitzheim teaches the silicon nitride passivation layer is also used for **antireflection**, as is “known in the art.” *Id.*, [0030]-[0031], [0060]. Thus, a POSITA would have understood Froitzheim’s formation of a silicon nitride layer as forming an *antireflective layer*. Ex.1003-Decl., ¶¶182-183.

Moreover, as shown below, the *antireflective* silicon nitride *layer* is formed **over** the textured **n-type silicon layer**. Ex.1004-Froitzheim, [0024], [0039]. It was known that antireflection coatings were applied over textured substrates. Froitzheim also teaches the antireflective silicon nitride layer is applied after texturing the **n-type silicon layer**, meaning the *antireflective* silicon nitride *layer* is formed *over the textured surface of the n-type silicon layer*. *Id.*, [0038]-[0039], [0050], [0060].



Ex.1004-Froitzheim, Fig.1.



Ex.1004-Froitzheim, Fig.3.¹⁰ Ex.1003-Decl., ¶¶184-185.

7. Claim 16

Claim 16 is narrower than claim 9 because it includes *forming an oxide layer over a back surface of a silicon substrate*. Claim 16 is obvious over the combination of Froitzheim and Gan. Ex.1003-Decl., ¶186.

a. 16[pre]

As described in Section X.A.2.a, Froitzheim and Gan teach this element. Ex.1003-Decl., ¶187.

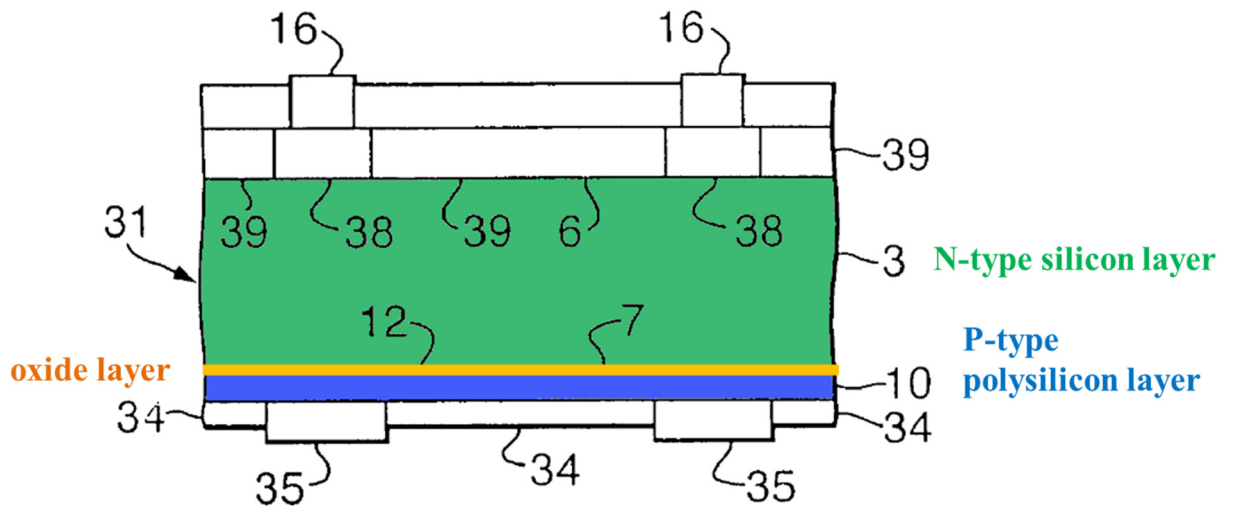
b. 16[a]-[b]

The combination of Froitzheim and Gan teaches *forming an oxide layer over a back surface of a silicon substrate* (16[a]) and *forming a layer of polysilicon over the oxide layer* (16[b]). Gan teaches forming a “thermally grown interfacial oxide” (i.e., *oxide layer*) over the surface of a silicon substrate. Ex.1005-Gan, 245. As discussed in Section X.A.1, Gan teaches that this oxide layer between a p-type

¹⁰ Figure 3 contains additional layers and contacts as compared to Figure 1 but is otherwise identical. Ex.1004-Froitzheim, [0033]-[0034]. A POSITA would have understood that the top layer in Figure 3 is the **passivation layer**. Ex.1003-Decl., ¶184.

emitter and silicon substrate improves cell efficiency. Ex.1005-Gan, 249. Ex.1003-Decl., ¶¶188-189.

As discussed in Section X.A.1, a POSITA would have been motivated to modify Froitzheim to implement a **P-type polysilicon emitter** and **oxide layer** between the back surface of the **substrate** and the **polysilicon emitter**, with a reasonable expectation of success, which would involve *forming an interfacial oxide layer on the silicon's back surface, forming a layer of polysilicon over the oxide layer, and then doping the polysilicon to form the emitter.*



Ex.1004-Froitzheim, Fig.3; Ex.1005-Gan, 245-249. Ex.1003-Decl., ¶190.

c. 16[c]-[e]

As described in Sections X.A.2.c-f, the combination of Froitzheim and Gan teaches these elements. Accordingly, the combination of Froitzheim and Gan renders claim 16 obvious. Ex.1003-Decl., ¶¶191-192.

8. Claim 17

Claim 17 depends from claim 16. Petitioner incorporates Section X.A.7. As discussed in Sections X.A.2.d and X.A.7, the combination of Froitzheim and Gan teaches claim 17. Ex.1003-Decl., ¶193.

9. Claim 18

Claim 18 depends from claim 16. Petitioner incorporates Section X.A.7. As discussed in Sections X.A.5 and X.A.7, the combination of Froitzheim and Gan teaches claim 18. Ex.1003-Decl., ¶194.

10. Claim 19

Claim 19 depends from claim 16. Petitioner incorporates Section X.A.7. As discussed in Section X.A.6, Froitzheim teaches claim 19. Ex.1003-Decl., ¶195.

11. Claim 20

Claim 20 depends from claim 19. Petitioner incorporates Section X.A.10. As discussed in Section X.A.6, Froitzheim teaches claim 20. Ex.1003-Decl., ¶196.

B. Ground II: Claims 1-20 Are Invalid as Obvious over Froitzheim, Gan, and Smith

Ground II challenges every claim of the '053 patent. Smith discloses additional teachings of the routine fabrication steps recited in the '053 patent's claims. To the extent PO argues that any of these routine steps were not obvious in

view of Froitzheim and Gan, such steps would have been obvious in view of Froitzheim, Gan, and Smith. Ex.1003-Decl., ¶197.

1. Motivation to Combine

Each requirement for obviousness is met here. Smith is analogous art for the same reasons as Froitzheim and Gan. Section X.A.1; Ex.1007-Smith, Abstract, 1:15-61. Smith is analogous art because its goals include decreasing the cost to fabricate an efficient solar cell, which is also a goal of the '053 patent and would have been an important consideration in determining how to best manufacture Froitzheim's and Gan's solar cells. Ex.1007-Smith, 1:15-40, 3:40-4:2; Ex.1001-USP053 1:47-49, 3:49-55. Ex.1003-Decl., ¶198.

The reasons a POSITA would have been motivated to combine Froitzheim, Gan, and Smith with a reasonable expectation of success include those discussed in Ground I and are incorporated here. Section X.A.1. Specifically, a POSITA would have understood the combination of Froitzheim, Gan, and Smith amounts to use of a known feature (Gan's polysilicon emitter and oxide layer) and technique (Smith's manufacturing steps) to improve a similar device (Froitzheim's back-junction solar cell) to achieve goals common to the references and the industry (increasing efficiency while minimizing costs). Indeed, a POSITA would have understood that

Smith teaches techniques that reduce manufacturing costs without sacrificing quality. Ex.1003-Decl., ¶199.

A POSITA looking to manufacture Froitzheim's back-junction solar cell with Gan's polysilicon emitter and oxide layer would have known that decreasing manufacturing costs was, like increasing cell efficiency, an important consideration. Although, as discussed, the efficiency of a solar cell is important, a POSITA would have understood costs and efficiencies are not necessarily mutually exclusive. A POSITA would have considered techniques that could be used to obtain lower costs without significant sacrifices to efficiency—which is ultimately a balance a POSITA would consider in view of the specific application a cell is being designed for. Ex.1001-USP053, 3:49-55 (acknowledging cost as an important consideration). Ex.1003-Decl., ¶200.

Solar cell fabrication requires numerous manufacturing steps. For example, Froitzheim teaches driving in p-type dopants at a temperature between 900-1200°C. Ex.1004-Froitzheim, [0042]; *see also* Ex.1005-Gan, 246 (900-1000°C). Froitzheim teaches an additional manufacturing step to drive in dopants for the n⁺ layers. Ex.1004-Froitzheim, [0044]-0045]. Each manufacturing step (e.g., each separate doping and heating step) increases costs, and reducing cell manufacturing costs is important, especially for commercial cells. Ex.1003-Decl., ¶201.

As discussed in Section X.A, a POSITA would have known how to implement Gan's polysilicon emitter and oxide layer in Froitzheim's solar cell and would have understood that the additional manufacturing steps taught by Froitzheim were required to manufacture a complete cell. Thus, a POSITA considering fabricating the combination of Froitzheim and Gan would have considered ways to decrease manufacturing costs. Ex.1003-Decl., ¶202.

Smith specifically teaches "techniques for simplifying the fabrication of solar cells." Ex.1007-Smith, 1:36-40. A POSITA would have considered Smith's simplified manufacturing teachings to obtain the benefits of Froitzheim's and Gan's solar cells at a lower cost to make. Ex.1003-Decl., ¶203.

Smith contains multiple teachings that a POSITA would have applied to the combination of Froitzheim and Gan to make a cost-efficient and high-quality cell. Although Smith teaches its diffusion steps for a "back contact" solar cell, where the metal contacts are all at the cell's back side, a POSITA would have understood that Smith's fabrication techniques are not limited to one structure and are advantageous and applicable to manufacture the combined structure of Froitzheim and Gan. *See, e.g.*, Ex.1007-Smith, 2:7-13, 4:11-16, claim 9 (not reciting "back contact solar cell"), claim 17 (same), Fig.7. Ex.1003-Decl., ¶204.

For instance, Smith teaches that dopants can be deposited on the substrate using “APCVD.” Ex.1007-Smith, 2:44-49. APCVD creates a layer of dopants on one side of the solar cell intended to be doped, which serves as a dopant source. After APCVD, “an undoped silicon dioxide” layer can be placed on the dopant source. Ex.1007-Smith, 2:53-60. The undoped silicon dioxide layer acts as a barrier to diffusion, meaning that the dopants are diffused only in the intended target region. *Id.*, 3:50-55. Smith teaches that these steps “advantageously allow[] for one-sided deposition,” which is “particularly useful in the manufacture of back side contact solar cells where only one side of the solar cell is textured.” *Id.*, 2:58-62. Ex.1003-Decl., ¶¶205-206.

A POSITA would have understood that achieving one-sided deposition as Smith teaches would make fabrication more efficient and less costly, because the dopants could be placed on just the desired side. In processes where this is not possible, the doping process requires additional steps (and thus costs) because the dopants are also placed on undesired sides and must be removed, such as by etching them off. Ex.1003-Decl., ¶207.

If PO argues the combination of Froitzheim and Gan do not teach forming dopant source layers to diffuse dopants, a POSITA would have been motivated to use Smith’s APCVD process to dope Gan’s polysilicon layer and the n+ layer on the

frontside of Froitzheim's substrate. Doing so would ensure that dopants are introduced into the desired layers while minimizing manufacturing steps. Ex.1003-Decl., ¶208.

A POSITA also would have been motivated to apply Smith's "in-situ steps" to the combination of Froitzheim and Gan to drive in the dopants to their target regions, which "simplifies the fabrication process." Ex.1007-Smith, 3:40-4:2. Smith explains that in-situ diffusion means that the steps are "performed in one loading of [the] wafer [] into the wafer processing tool." *Id.*, 3:40-42. A POSITA would have found this advantageous because it would simplify the process and decrease costs. Ex.1003-Decl., ¶209.

A POSITA would have understood that Smith's APCVD, diffusion barrier, and in-situ diffusion processes applied to Froitzheim's and Gan's methods would have been desirable because the front side and the back side of the wafers could be doped at the same time, decreasing cost and the number of required steps. Otherwise, the wafer would have to be removed from the machine, prepared for the next loading (such as by applying masking layers to protect previously doped surfaces), reloaded into the machine, and then further processed (such as by removing the masking layers), increasing cost from the added steps. Ex.1003-Decl., ¶210.

Finally, in addition to the reasons in Section X.A.1, a POSITA would have reasonably expected success at using Smith's manufacturing techniques to manufacture the combination of Froitzheim and Gan, including because the references teach compatible manufacturing steps and the manufacturing steps were well-known and routine steps that were within a POSITA's skillset. *Uber*, 957 F.3d at 1339. Thus, using Smith's teachings to manufacture the combination of Froitzheim and Gan simply involves using known manufacturing techniques to improve known solar cell designs in a similar way. *KSR*, 550 U.S. at 417; *Tokai*, 632 F.3d at 1372. Ex.1003-Decl., ¶¶211-213.

2. Claim 9

a. 9[pre]

As discussed in Section X.A.2.a, Froitzheim and Gan teach this element. Ex.1003-Decl., ¶214.

Smith also teaches this element. Ex.1007-Smith, Title, Figs.1-7, 1:15-19, 1:44-4:11, claims 1-20. As discussed in Section X.B.1, a POSITA would have been motivated to modify the combination of Froitzheim and Gan in view of Smith with a reasonable expectation of success. Ex.1003-Decl., ¶215.

b. 9[a]

As discussed in Section X.A.2.b, the combination of Froitzheim and Gan teaches this element. Ex.1003-Decl., ¶216.

c. 9[b]-[c]

As discussed in Section X.A.2.c-d, the combination of Froitzheim and Gan teaches this element. Ex.1003-Decl., ¶217.

Smith also teaches forming a *first dopant source layer and diffusing dopants from the first dopant source layer*. Smith teaches “a method of forming doped regions in a substrate of a back side contact solar cell [that] includes the steps of depositing a **first doped oxide layer** [*i.e., first dopant source layer*] on a back side of **[an N-type] substrate**...[and] diffusing a first dopant from the first doped oxide layer into the substrate to form a first doped region in the substrate.” Ex.1007-Smith, Abstract, 1:43-3:55. Smith teaches the “**first doped oxide layer**” is “boron-doped silicon dioxide (SiO₂) (‘BSG’),” which is a P-type dopant source. *Id.*, 2:44-49, 3:44-47; *see also* Ex.1001-USP053, 4:21-24 (discussing BSG). Smith’s Figure 2 (below) depicts the **first doped oxide layer** (“boron-doped silicon dioxide 104,” a P-type dopant source layers) is formed over the **substrate**. Ex.1007-Smith, 2:44-64.



Ex.1007-Smith, Fig.2. As discussed in Section X.B.1, a POSITA would have been motivated to modify the combination of Froitzheim and Gan to implement Smith’s diffusion methods with a reasonable expectation of success, which would involve forming a polysilicon layer, creating a *dopant source layer* over the polysilicon layer, and then *diffusing dopants from the source layer* into the polysilicon. Ex.1003-Decl., ¶¶218-220.

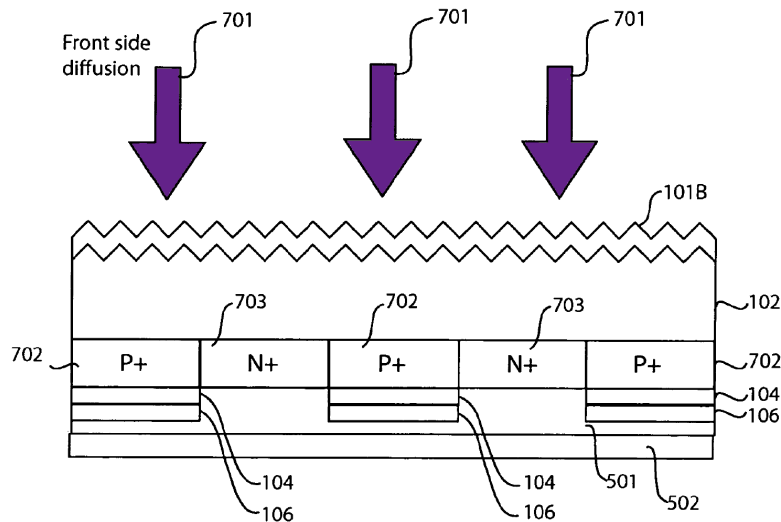
d. 9[d]

As discussed in Section X.A.2.e, Froitzheim teaches this element. Ex.1003-Decl., ¶221.

Smith also teaches this element. Smith teaches a “[w]afer 102 [that] serves as the substrate of the solar cell being fabricated,” which has “a front side 101 and a back side 103[,]” and the “[f]ront side 101 is the side of the solar cell...faces the sun in operation.” Ex.1007-Smith, 2:32-37. Smith teaches “diffusing a second dopant into the substrate by way of a front side [(i.e., *the front surface of the silicon substrate facing the sun during normal operation*)] of the substrate.” Ex.1007-Smith, Abstract, 1:43-3:55, claims 1-2, 4, 8, 9, 12, 14-19. Ex.1003-Decl., ¶¶222-223.

Specifically, Smith teaches diffusing phosphorus “as an N-type dopant into wafer 102 from its front side.” Ex.1007-Smith, 3:56-60. Smith’s frontside diffusion

step (i.e., diffusing dopants into *the front surface of the silicon substrate*) is shown in Figure 7 by the arrows pointing to the substrate's front. *Id.*, 3:40-61.



Ex.1007-Smith, Fig.7. As discussed in Section X.B.1, a POSITA would have been motivated to modify the combination of Froitzheim and Gan to implement Smith's diffusion methods with a reasonable expectation of success, which would involve diffusing dopants into the top of Froitzheim's silicon substrate. Ex.1003-Decl., ¶¶224-225.

e. 9[e]

As discussed in Section X.A.2.f, Froitzheim teaches this element. Accordingly, the combination of Froitzheim, Gan, and Smith renders claim 9 obvious. Ex.1003-Decl., ¶¶226-227.

3. Claim 10

Claim 10 depends from claim 9. Petitioner incorporates Section X.B.2. As discussed in Section X.B.2.c, the combination of Froitzheim, Gan, and Smith teaches this element. *E.g.*, Ex.1007-Smith, 2:63-64 (“doped with P-type dopants”). Ex.1003-Decl., ¶228.

4. Claim 11

Claim 11 depends from claim 9. Petitioner incorporates Section X.B.2. As discussed in Section X.A.4, the combination of Froitzheim and Gan teaches this element. Ex.1003-Decl., ¶229.

As discussed in Section X.B.2.c, Smith teaches the **first doped oxide layer 104** (i.e., *first dopant source layer*) is “boron-doped silicon dioxide (SiO₂) (‘BSG’),” which is a p-type dopant source. Ex.1007-Smith, 2:44-64; *see also* Ex.1001-USP053, 4:21-24 (discussing BSG).



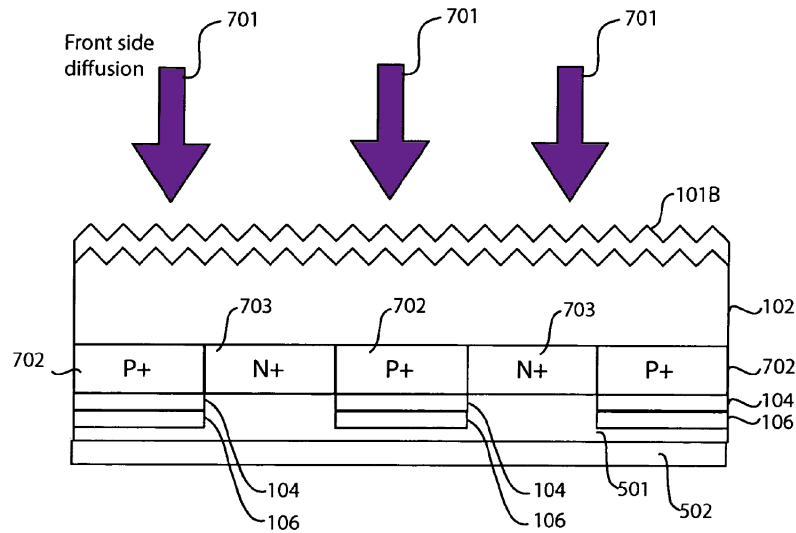
Ex.1007-Smith, Fig.2. As discussed in Section X.B.1, a POSITA would have been motivated to modify the combination of Froitzheim and Gan to implement Smith’s

diffusion methods with a reasonable expectation of success, which would involve forming a *first dopant source layer comprising borosilicate glass* to dope the polysilicon emitter. Ex.1003-Decl., ¶230.

5. Claim 12

Claim 12 depends from claim 9. Petitioner incorporates Section X.B.2. As discussed in Section X.A.5, Froitzheim teaches these elements. Ex.1003-Decl., ¶231.

Smith also teaches these elements. *See* Section X.B.2.d. Smith's Figure 7 teaches a method of diffusing phosphorus dopants *into the front surface of the silicon substrate comprising forming second dopant source layer* (phosphorus dopant layer) *over the silicon substrate and diffusing dopants from the second dopant source layer into the silicon substrate*. The **arrows (“front side diffusion” 701)** below indicate dopant being driven into substrate by diffusion. Smith explains that in step 701, “phosphorus oxychloride” (POCl₃) is used, which involves (1) forming a layer of glass with phosphorous dopants at the silicon surface (*i.e., forming a second dopant source layer*), and (2) diffusing phosphorous dopants from the glass layer into the silicon substrate (*i.e., diffusing dopants*). Ex.1007-Smith, 3:56-60, claims 1, 9, 14, 17, 20; *e.g.*, Ex.1052-Avery, 1:19-31.



Ex.1007-Smith, Fig.7. As discussed in Section X.B.1, a POSITA would have been motivated to modify the combination of Froitzheim and Gan to implement Smith's diffusion methods with a reasonable expectation of success. Ex.1003-Decl., ¶¶232-234.

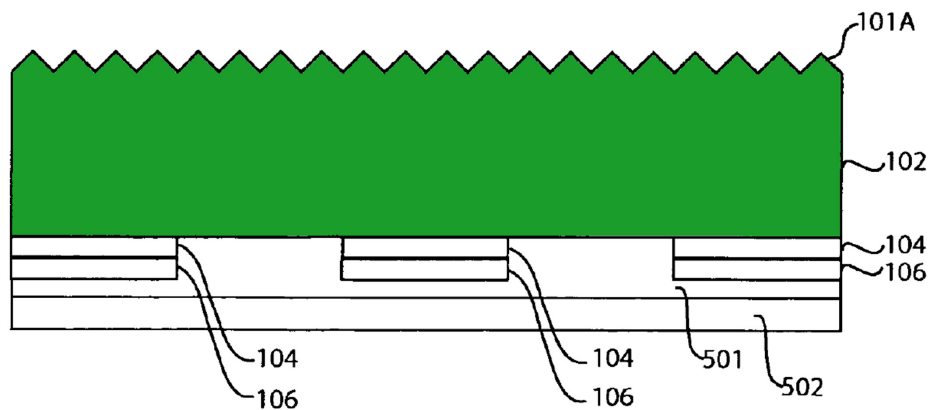
6. Claim 13

Claim 13 depends from claim 12. Petitioner incorporates Section X.B.5. The combination of Froitzheim, Gan, and Smith teaches this element. As discussed in Section X.B.5, Smith teaches forming a layer of glass with phosphorous dopants (i.e., *phosphorus doped silicon dioxide*) as part of the POCl_3 diffusion. Ex.1003-Decl., ¶235.

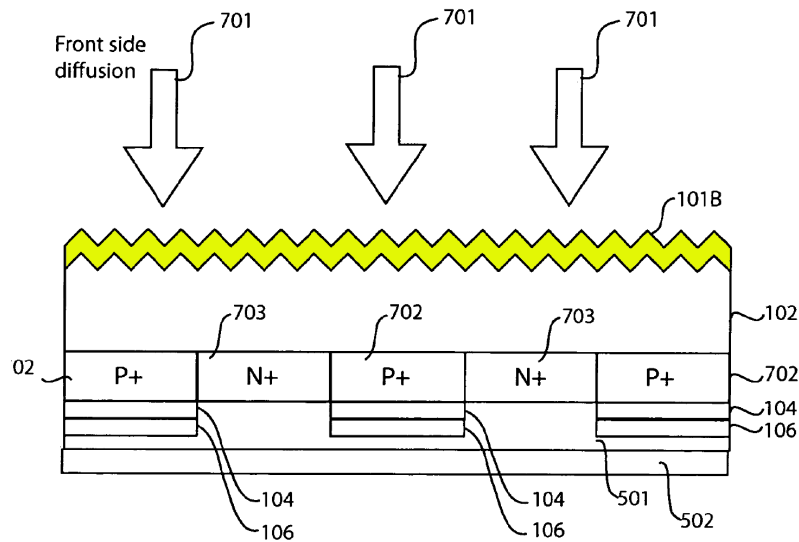
7. Claim 14

Claim 14 depends from claim 9. Petitioner incorporates Section X.B.2. As discussed in Section X.A.6, Froitzheim teaches this element. Ex.1003-Decl., ¶236.

Smith also teaches claim 14. Smith Figure 6 depicts texturing the front side “using a wet etch process.” Ex.1007-Smith, 3:32-38, 2:60-62. The textured surface is shown by **jagged edges**:



Ex.1007-Smith, Fig.6. Smith Figure 7 teaches forming “an anti-reflective coating (e.g., silicon nitride) on front side 101B.” *Id.*, 4:3-6.



Ex.1007-Smith, Fig.7. As discussed in Section X.B.1, a POSITA would have been motivated to modify Froitzheim to implement Smith's manufacturing methods with a reasonable expectation of success, including texturing and anti-reflective coating (which were common features). Ex.1003-Decl., ¶¶237-238.

8. Claim 15

Claim 15 depends from claim 9. Petitioner incorporates Section X.B.2. The combination of Froitzheim, Gan, and Smith teaches the element. As discussed in Section X.B.2.c-d, the combination of Froitzheim, Gan, and Smith teaches *the diffusion of dopants from the first dopant source layer to the layer of polysilicon and the diffusion of dopants into the front surface of the silicon substrate*. This combination also teaches *performing these diffusion steps in situ*. Ex.1003-Decl., ¶¶239-240.

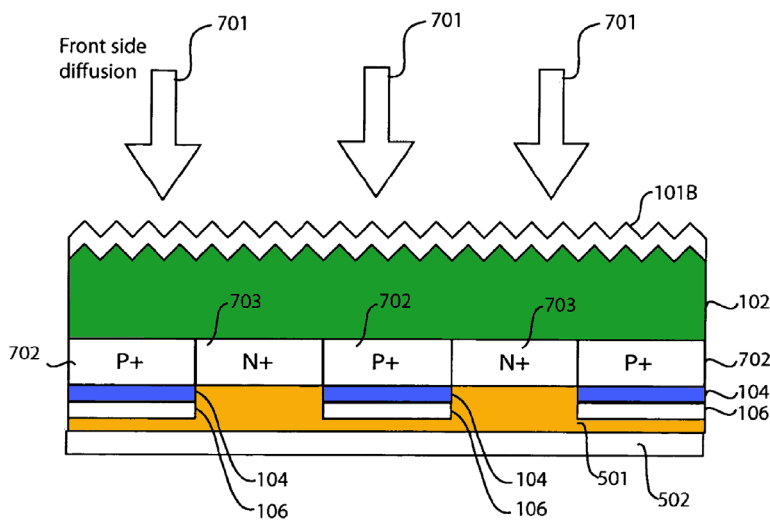
The '053 patent explains that “in-situ” “means a single manual (i.e., by fabrication personnel) loading of the substrate 101 in a furnace or other single chamber or multi-chamber processing tool.” Ex.1001-USP053, 5:9-18. That is, “in-situ” in the context of the '053 patent refers to multiple processing steps that occur after a single manual loading of the substrate in a furnace. *Id.* By 2008, this process was sometimes known as “co-diffusion.” *E.g.*, Ex.1019-Krygowski, 1. Ex.1003-Decl., ¶241.

Smith teaches in situ deposition and recites the same **teachings** and **benefits** purported in the '053 patent:

Ex.1001-USP053	Ex.1007-Smith
“The drive-in step to dope the polysilicon emitter 108 on the backside and to form the N-type doped regions...on the front side may be formed in-situ, which in the context of the present disclosure means a single manual (i.e., by fabrication personnel) loading of the substrate 101 in a furnace.” 5:9-15.	“In Fig. 7, the sample of Fig. 6 is subjected to in-situ steps. The steps are in-situ in that they are performed in one loading of wafer 102 into the wafer processing tool. ” 3:40-42.
“[T]he drive-in step is performed in a diffusion furnace. ” 5:15-16.	“[T]he in-situ steps are performed in a furnace. ” 3:42-43.
“[I]n-situ diffusion... advantageously helps in lowering fabrication cost. ” 5:16-18.	“[T]he use of in-situ steps to drive dopants into wafer 102 simplifies the fabrication process. ” 3:66-4:2.

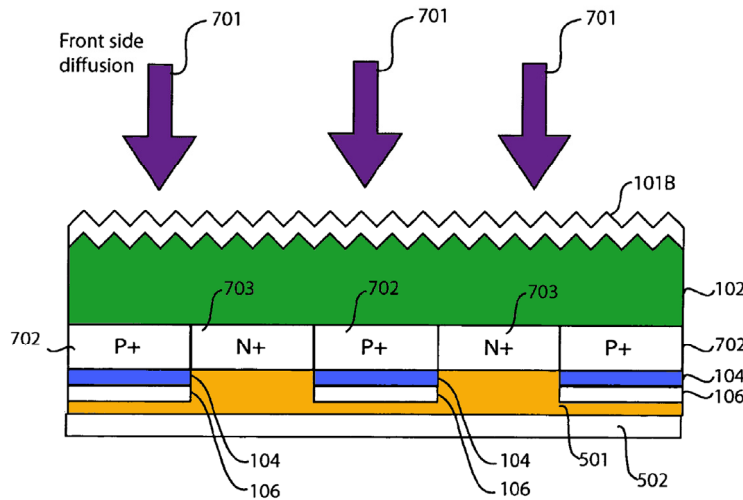
Specifically, Smith teaches fabricating a solar cell by performing *in situ* diffusion of different types of dopants to the cell’s frontside and backside. Ex.1007-

Smith, 3:40-4:22, Abstract, claims 1-2, 9, 10. Smith teaches a “first in-situ step” to diffuse **p-type dopants 104** and **n-type dopants 501** to the substrate’s backside: “**wafer 102** is heated to about 1000 C. for one hour to diffuse dopants from **boron-doped silicon dioxide 104** and **phosphorus-doped silicon dioxide 501** into **wafer 102**.” *Id.*, 3:40-55.



Ex.1007-Smith, Fig.7. Ex.1003-Decl., ¶¶242-245.

Smith also teaches a “second in-situ step” where “**the furnace conditions are changed to...diffuse phosphorus as an N-type dopant** into **wafer 102** from its front side.” *Id.*, 3:40-4:2; Ex.1001-USP053, 5:9-15.



Ex.1007-Smith, Fig.7, 3:40-4:2, Abstract, claims 1-2, 9, 10, 20. Thus, because Smith teaches loading the substrate into the furnace once and then performing processing steps, Smith teaches the recited *in situ* step. Ex.1003-Decl., ¶246.

As discussed in Section X.B.1, a POSITA would have been motivated to modify the combination of Froitzheim and Gan to implement Smith's diffusion methods with a reasonable expectation of success, which would involve doping the frontside and backside using Smith's *in situ* steps. Ex.1003-Decl., ¶247.

9. Claim 16

a. 16[pre]

As discussed in Section X.B.2.a, Froitzheim, Gan, and Smith teach this element. Ex.1003-Decl., ¶249.

b. 16[a]-[b]

As discussed in Section X.A.7.b, the combination of Froitzheim and Gan teaches these elements. Ex.1003-Decl., ¶250.

c. 16[c]-[e]

As described in Sections X.A.7.c and X.B.2.c-e, the combination of Froitzheim, Gan, and Smith teaches this element. As discussed in Section X.B.1, a POSITA would have been motivated to modify Froitzheim in view of Gan and Smith. Accordingly, the combination of Froitzheim, Gan, and Smith renders claim 16 obvious. Ex.1003-Decl., ¶¶248, 251-252.

10. Claim 17

Claim 17 depends from claim 16. Petitioner incorporates Section X.B.9. As discussed in Sections X.A.2.c-d, X.A.7, X.B.2.c, X.B.9, the combination of Froitzheim, Gan, and Smith teaches claim 17. Ex.1003-Decl., ¶253.

11. Claim 18

Claim 18 depends from claim 16. Petitioner incorporates Section X.B.9. As discussed in Sections X.B.5 and X.B.9, Froitzheim and Smith teach claim 18. Ex.1003-Decl., ¶254.

12. Claim 19

Claim 19 depends from claim 16. Petitioner incorporates Section X.B.9. As discussed in Section X.B.7, Froitzheim and Smith teach claim 19. Ex.1003-Decl., ¶255.

13. Claim 20

Claim 20 depends from claim 19. Petitioner incorporates Section X.B.12. As discussed in Section X.B.7, Froitzheim and Smith teach claim 20. Ex.1003-Decl., ¶256.

14. Claim 1

Claim 1 is narrower than claim 9 because it recites (1) the dopant type (N- vs. P-Type) and (2) “forming a capping layer.” Nonetheless, each feature is obvious over the combination of Froitzheim, Gan, and Smith. Ex.1003-Decl., ¶257.

a. 1[pre]-1[b], 1[d]

Petitioner incorporates Sections X.A.2.a-d and X.B.2.a-c. Ex.1003-Decl., ¶¶258-260, 266.

b. 1[c]

The combination of Froitzheim, Gan, and Smith teaches *forming a capping layer over the P-type dopant source*. Froitzheim and Gan teach a P-type dopant source. See Sections X.A.2.c and X.B.2.c. Smith further teaches “*forming a capping layer over the P-type dopant source*.” Ex.1003-Decl., ¶¶261-262.

Smith teaches “a method of forming doped regions in a substrate of a back side contact solar cell [that] includes the steps of [1] depositing a **first doped oxide layer** [i.e., *dopant source*] on a back side of a substrate, [2] depositing a **first undoped oxide layer** [i.e., *forming a capping layer*] over the first doped oxide layer, and [3] diffusing a first dopant from the first doped oxide layer into the substrate to form a first doped region in the substrate.” Ex.1007-Smith, Abstract, 1:43-3:55, claims 1-5, 11-13. Smith teaches the “**first doped oxide layer**” may be “boron-doped silicon dioxide (SiO₂) (‘BSG’)” (i.e., *p-type dopant source*) and the “**undoped silicon dioxide 106** is deposited...by APCVD.” *Id.*, 2:44-64, 2:55-57; *see also* Ex.1001-USP053, 4:21-25 (discussing BSG).



Ex.1007-Smith, Fig.2. Ex.1003-Decl., ¶¶263-264.

A POSITA would have understood the undoped oxide layer is a capping layer, including because Smith teaches the undoped oxide layer prevents the dopants from moving to unintended locations. Ex.1007-Smith, claim 11, 2:57-62 ; Ex.1001-USP 053, 4:18-21. As discussed in Section X.B.1, a POSITA would have been motivated

to modify Froitzheim to implement Smith's diffusion methods with a reasonable expectation of success. Ex.1003-Decl., ¶265.

c. 1[e]

Petitioner incorporates Sections X.A.2.e and X.B.2.d. Ex.1003-Decl., ¶267.

d. 1[f]

Petitioner incorporates Sections X.A.2.f and X.B.2.e. Accordingly, the combination of Froitzheim, Gan, and Smith renders claim 1 obvious. Ex.1003-Decl., ¶¶268-269.

15. Claim 2

Claim 2 depends from claim 1. Petitioner incorporates Section X.B.14. As discussed in Sections X.A.4 and X.B.4, the combination of Froitzheim, Gan, and Smith teaches this element. Ex.1003-Decl., ¶270.

16. Claim 3

Claim 3 depends from claim 1. Petitioner incorporates Section X.B.14. As discussed in Sections X.A.5 and X.B.5, Froitzheim and Smith teach this element. Ex.1003-Decl., ¶271.

17. Claim 4

Claim 4 depends from claim 3. Petitioner incorporates Section X.B.16. As discussed in Section X.B.6, the combination of Froitzheim, Gan, and Smith teaches claim 4. Ex.1003-Decl., ¶272.

18. Claim 5

Claim 5 depends from claim 1. Petitioner incorporates Section X.B.14. As discussed in Sections X.A.6 and X.B.7, Froitzheim and Smith teach claim 5. Ex.1003-Decl., ¶273.

19. Claim 6

Claim 6 depends from claim 5. Petitioner incorporates Section X.B.18. As discussed in Sections X.A.6 and X.B.7, Froitzheim and Smith teach claim 6. Ex.1003-Decl., ¶274.

20. Claim 7

Claim 7 depends from claim 1. Petitioner incorporates Section X.B.14. As discussed in Section X.B.8, the combination of Froitzheim, Gan, and Smith teaches claim 7. Smith also teaches diffusing *P-type dopants and N-type dopants in situ*, which was known in the art. Ex.1019-Krygowski; Ex.1055-Bueno; Section X.B.8. Ex.1003-Decl., ¶¶275-276.

21. Claim 8

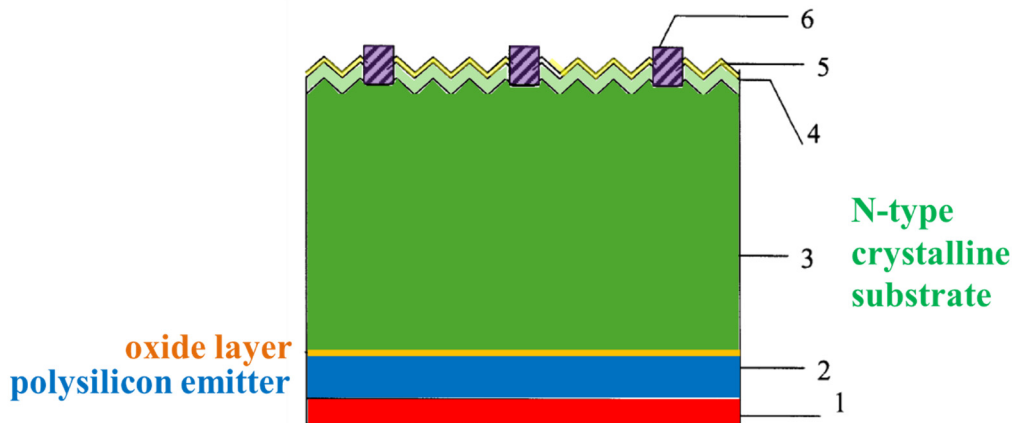
Claim 8 depends from claim 1. Petitioner incorporates Section X.B.14. As discussed in Section X.B.14.b, the combination of Froitzheim, Gan, and Smith teaches claim 8. Ex.1003-Decl., ¶277.

C. Ground III: Claims 9-20 Are Invalid as Obvious over Li, Gan, and Smith

1. Motivation to Combine

Each requirement for obviousness is met here. As with Grounds I and II, Li is analogous art because it is in the same field as the Challenged Claims (solar cells) and is reasonably pertinent to solving the problems addressed in the Challenged Claims (increasing efficiency) with the same types of solutions (optimizing solar cell configuration). Ex.1008-Li, 1-4; Section X.A.1. Li is also focused on decreasing manufacturing costs. Ex.1008-Li, 3. Ex.1003-Decl., ¶279.

As with Ground I, the combination of Li and Gan amounts to use of a known technique and feature (Gan's polysilicon emitter and oxide layer between the PN junction) to improve a similar device (Li's backside junction solar cell) to achieve goals common to both references and the industry (increasing efficiency). A POSITA would have been motivated to modify Li's methods of making a backside junction solar cell to incorporate Gan's methods of using a polysilicon emitter and oxide layer structure below:



Ex.1008-Li, Fig.1; Ex.1005-Gan, 245-249. Ex.1003-Decl., ¶¶280-281.

The reasons a POSITA would have been motivated to combine Li, Gan, and Smith with a reasonable expectation of success include those discussed in Grounds I and II and are incorporated here. Sections X.A.1 and X.B.1. As with Froitzheim, Li teaches fabricating solar cell structures having a backside PN junction with an n-type substrate and p-type emitter to improve a cell's efficiency. Ex.1008-Li, p.4. As discussed in Section X.A.1, a POSITA would have considered and applied the teachings of Gan and others regarding the benefits of a polysilicon emitter and tunnel oxide layer, as applied to a backside configuration. For instance, Gan specifically teaches adding a polysilicon emitter and oxide layer structure to improve the efficiency of a solar cell. Ex.1005-Gan, 249. Gan explains that its teachings were directly applicable to solar cells with p-type emitters and backside PN junctions, just like in Li. *Id.*, 246, 248-249; Ex.1008-Li, p.4. As with Froitzheim, a POSITA would have been motivated to retain fabrication steps that resulted in Li's backside junction

solar cell design to avoid the potential absorption drawbacks of placing a polysilicon emitter at the front side. Ex.1003-Decl., ¶¶282-286.

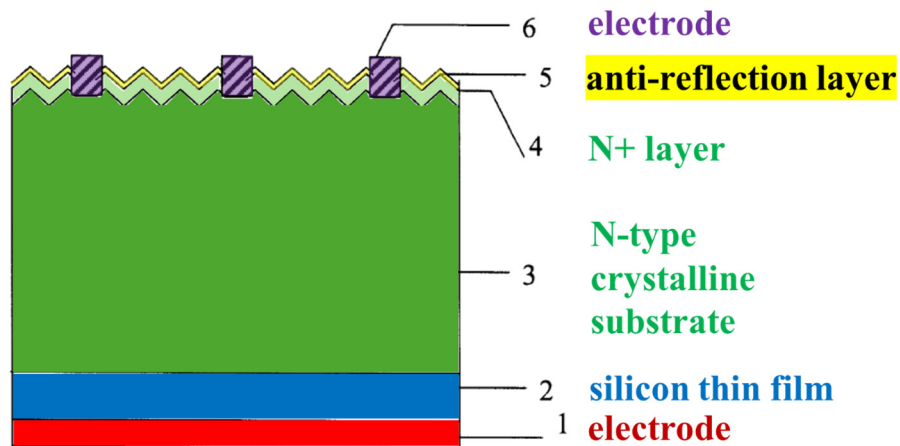
As discussed in Section X.B.1, a POSITA would have been motivated to obtain the manufacturing efficiencies Smith teaches. As with Froitzheim, a POSITA looking to manufacture Li's rear junction solar cell with Gan's polysilicon emitter and oxide layer would have known that decreasing manufacturing costs was, like increasing cell efficiency, an important consideration. For instance, a POSITA would have understood that Smith's APCVD, diffusion barrier, and in-situ diffusion processes applied to Li's and Gan's methods would have been desirable because the front side and the back side of the wafers could be doped at the same time, decreasing cost and the number of required steps. Section X.B.1. Therefore, a POSITA would have been motivated to manufacture the combination of Li and Gan using Smith's techniques because doing so would improve the efficiency of Li's cell and simplify the manufacturing process. Ex.1003-Decl., ¶¶287-288.

Moreover, a POSITA would have reasonably expected success at using Smith's manufacturing method for the Li and Gan combination for the reasons discussed in Sections X.A.1 and X.B.1, including because Li has a similar structure to Froitzheim and Gan. Ex.1003-Decl., ¶288.

2. Claim 9

a. 9[pre]

Li teaches this element. Ex.1008-Li, Title, Abstract, Claims 1-6, 3-4, Fig.1. Li specifically teaches a method of manufacturing a solar cell that includes: (1) providing a textured “N-type monocrystalline silicon wafer,” (2) doping the front surface of the wafer to create “a highly doped N⁺ layer,” (3) depositing an anti-reflection layer, such as SiN or SiO₂, over the N⁺ layer,” (4) depositing an emitter “on the back surface of the” wafer, and (5) adding electrodes. *Id.*, 4.

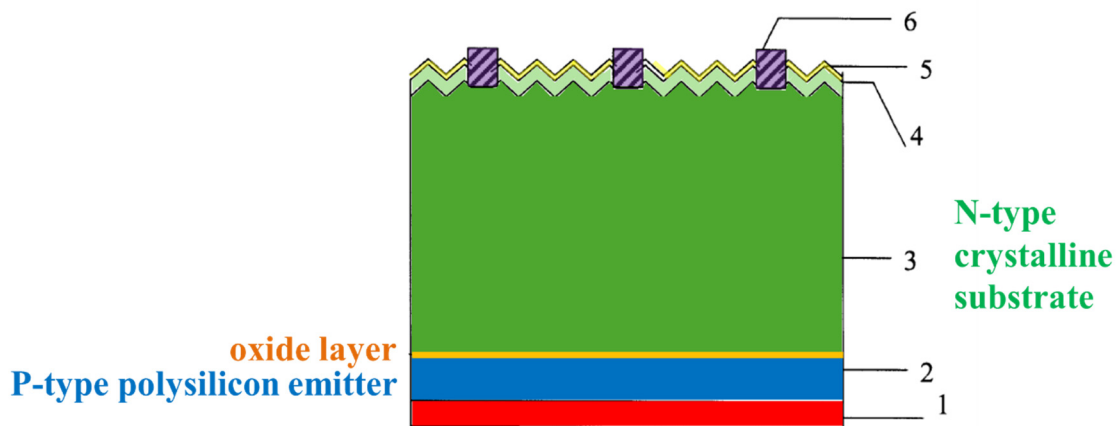


Ex.1008-Li, Fig.1. Ex.1003-Decl., ¶289.

Gan and Smith also teach this element. *See* Section X.B.2.a. Ex.1003-Decl., ¶290.

b. 9[a]

The combination of Li and Gan teaches this element. Li teaches depositing (i.e., *forming*) “[a] **layer of silicon thin film [2]** [i.e., a *layer of silicon*]...on a back surface of N-type monocrystalline silicon [i.e., *substrate substrate*] to form an emitting region.” Ex.1008-Li, 4, *see also id.*, Abstract, claims 1, 3, and 5, Fig.1. Li teaches the **layer of silicon thin film 2** is “P-type.” Ex.1008-Li, 4, claim 5.



Ex.1008-Li, Fig.1; Ex.1005-Gan, 245-249. Ex.1003-Decl., ¶¶291-292.

Gan teaches *forming a layer of polysilicon*. Ex.1005-Gan, 246 (“Polysilicon deposition”); Section X.A.2.b. As discussed in Section X.C.1, a POSITA would have been motivated to modify Li to replace Li’s **layer of silicon thin film** with Gan’s **P-type polysilicon emitter** with a reasonable expectation of success, which would involve *forming a layer of polysilicon* over the backside of Li’s **silicon substrate**. Ex.1003-Decl., ¶293.

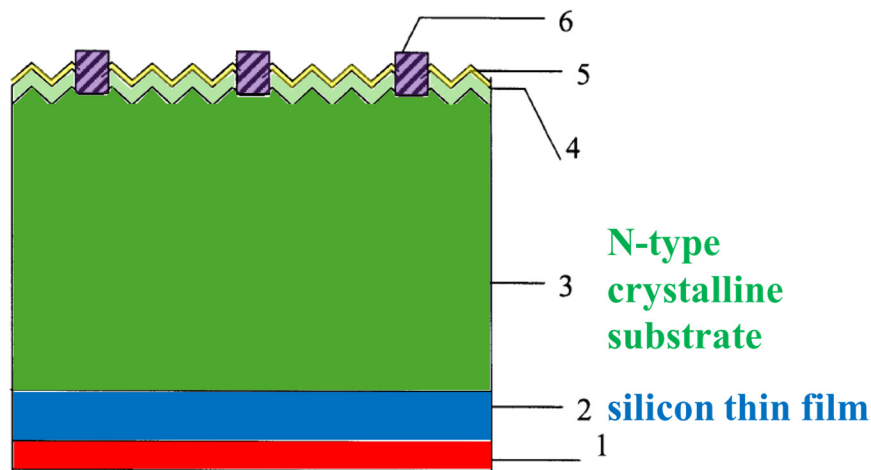
c. 9[b]

The combination of Li, Gan, and Smith teaches this element. Li teaches that “[a] layer of [P-type] silicon thin film is deposited on a back surface of N-type monocrystalline silicon to form an emitting region.” Ex.1008-Li, 4; *id.* 1-3 (discussing p-type emitters). Gan teaches a polysilicon emitter. Section IX.B. Thus, the combination of Li and Gan teaches a backside polysilicon emitter. Ex.1003-Decl., ¶¶294-295.

Gan and Smith both teach forming a dopant source layer. For example, as explained in Section X.B.2.b-c, step 4 of Gan’s “process sequence” deposits the “polysilicon” on the substrate, and step 9 deposits “[d]oped glass” (*i.e., forming a first dopant source layer*) on “both sides of the wafer” (*i.e., “over a layer of polysilicon”*), which contains p-type dopants that creates a “p-type polysilicon emitter” in step 10. Ex.1005-Gan, 246, 248. Smith further teaches forming a *first dopant source layer*. See Section X.B.2.c. As discussed in Section X.C.1, a POSITA would have been motivated to modify Li to replace Li’s **layer of silicon** with Gan’s polysilicon layer and utilize Gan’s or Smith’s methods of introducing a dopant source layer, with a reasonable expectation of success, which would involve *forming a dopant source layer over the layer of polysilicon* that is formed over the backside of Li’s **silicon substrate**. Ex.1003-Decl., ¶296.

d. 9[c]

The combination of Li, Gan, and Smith teaches this element. Li teaches forming a backside junction between a layer of silicon and a silicon substrate. A POSITA would have understood that Li's teaching of depositing **the layer of silicon thin film 2** (i.e., *layer of silicon*) on the "back surface" forms a *backside junction* with the **N-type silicon substrate** because **the layer of silicon thin film** is located on the back side of the solar cell and is oppositely doped from the **substrate**. Ex.1008-Li, 3 ("[A] PN junction is placed on the back surface of the cell."); Ex.1001-USP053, 1:53-55 (discussing a "backside junction").



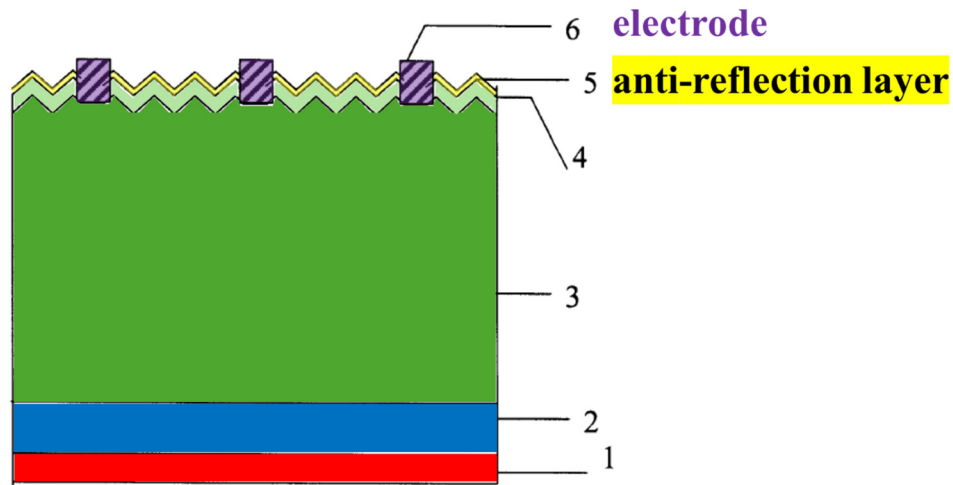
Ex.1008-Li, Fig.1. Ex.1003-Decl., ¶¶297-298.

Gan's method teaches diffusing dopants from a first dopant source layer to a layer of polysilicon. Gan teaches that after the doped glass is deposited on the layer of polysilicon (step 9), dopants from the doped glass are "Drive[n]-in [at] 900-1000

°C” in step 10, to the target layer (i.e., *polysilicon*). Ex.1005-Gan, 246. A POSITA would have understood that “driv[ing]-in” means diffusing dopants from the doped glass that had been deposited on the polysilicon layer. Ex.1005-Gan, 246. Smith further teaches diffusing dopants from a first dopant source layer to a silicon substrate. *See* Section X.B.2.c. As discussed in Section X.C.1, a POSITA would have been motivated to modify Li to replace Li’s deposited emitter (**layer of P-type silicon**) with Gan’s polysilicon emitter and implementing Gan’s or Smith’s methods of diffusing dopants from a dopant source layer, with a reasonable expectation of success. Ex.1003-Decl., ¶¶299-300.

e. 9[d]

Li and Smith teach this element. Li teaches fabricating a solar cell with *the front surface of the silicon substrate facing the sun during normal operation*. Li teaches fabricating a solar cell that has a “front” and “back surface.” Ex.1008-Li, Abstract, 4, Fig.1, claims 1-3. A POSITA would have understood the “front surface” faces the sun during normal operation and is opposite the back surface, including because Li depicts a textured front surface (jagged edges), an **anti-reflection layer**, and a front **electrode** that does not cover the entire surface, all of which are designed to facilitate sunlight penetrating the cell. *Id.*, 4.



Ex.1008-Li, Fig.1. Ex.1003-Decl., ¶¶301-302

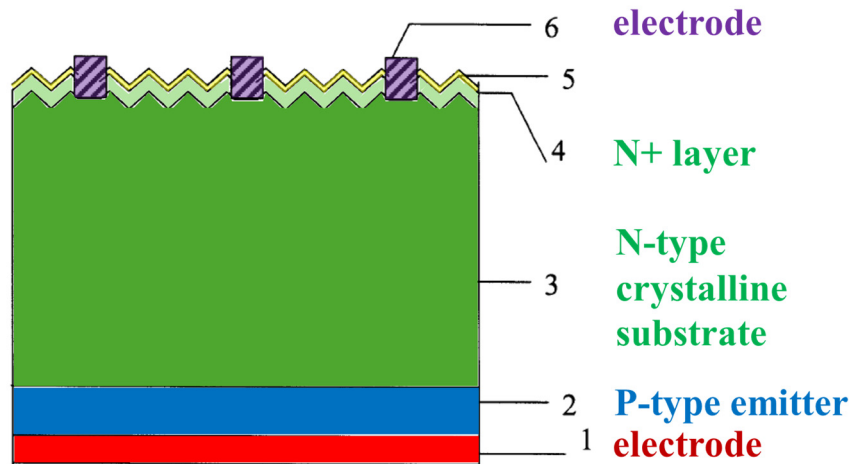
Li also teaches *diffusing dopants into a front surface of the silicon substrate*. Li teaches forming (by diffusion) “**a highly doped N+ layer (4)**...on the front surface” of the solar cell. Ex.1008-Li, 4. Ex.1003-Decl., ¶303.

Smith also teaches this element. *See* Section X.B.2.d. As discussed in Section X.C.1, a POSITA would have been motivated to modify Li to implement Smith’s diffusion methods with a reasonable expectation of success. Ex.1003-Decl., ¶304.

f. 9[e]

Li teaches this element. Li’s solar cell includes a front “**electrode**.” Ex.1008-Li, 4. A POSITA would have understood, as shown in Li’s Figure, that the **electrode** is electrically connected to the **N-type crystalline silicon substrate 3** (i.e., *substrate*) via the **highly doped N+ layer 4**. Ex.1008-Li, Fig.1, 4. Li’s solar cell

also includes a rear **electrode 1** on the back of a **silicon thin film 2** (i.e., *emitter layer*). Ex.1008-Li, Fig.1, 4.



Ex.1008-Li, Fig.1. Ex.1003-Decl., ¶¶305-306.

A POSITA would have understood that Li’s “electrodes” were *metal contacts*. For instance, Li explains the “*metal **electrode layer [1]*** on the back surface can re-reflect light that penetrates the cell back into the cell.” Ex.1008-Li, 4; *see also* 3 (discussing “a metal grid”). Likewise, Smith and Gan disclose forming metal contacts. Ex.1005-Gan, 246 (“Metal finger definition”); Ex.1007-Smith, 1:20-35, 1:44-57, 2:4-3:10, claim 1. Ex.1003-Decl., ¶¶307-308.

Accordingly, the combination of Li, Gan, and Smith renders claim 9 obvious. Ex.1003-Decl., ¶309.

3. Claim 10

Claim 10 depends from claim 9. Petitioner incorporates Section X.C.2. As discussed in Section X.C.2.c, the combination of Li, Gan, and Smith teaches claim 10. Ex.1003-Decl., ¶310.

4. Claim 11

Claim 11 depends from claim 9. Petitioner incorporates Section X.C.2. As discussed in Section X.C.2.c, the combination of Li, Smith, and Gan teaches claim 11. Ex.1003-Decl., ¶311.

5. Claim 12

Claim 12 depends from claim 9. Petitioner incorporates Section X.C.2. Li further teaches claim 12. Li teaches that “[a]fter surfaces [of the substrate] are cleaned and textured by a standard industrial process,” dopants are diffused into the front surface of substrate to form **a highly doped N+ layer (4)**. Ex.1008-Li, 4. A POSITA would understand that diffusing dopants into the front surface would have entailed creating a layer of dopants on the front surface and diffusing that layer into the substrate. *See* Section X.A.5. Ex.1003-Decl., ¶¶312-313.

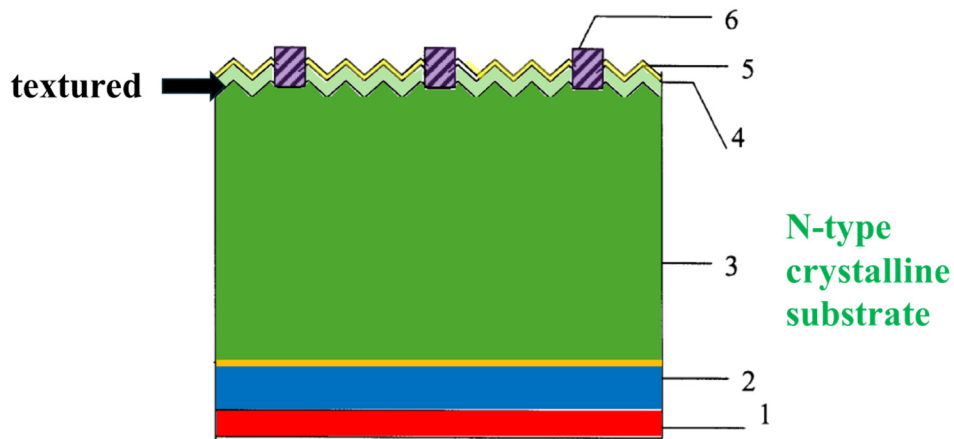
As discussed in Section X.C.2.e, Smith also teaches this claim. As discussed in Section X.C.1, a POSITA would have been motivated to modify Li in view of Smith. Ex.1003-Decl., ¶314.

6. Claim 13

Claim 13 depends from claim 12. Petitioner incorporates Section X.C.5. As discussed in Section X.B.6, combination of Li, Smith, and Gan teaches claim 13. *See also* Section X.B.5. Ex.1003-Decl., ¶¶315-316.

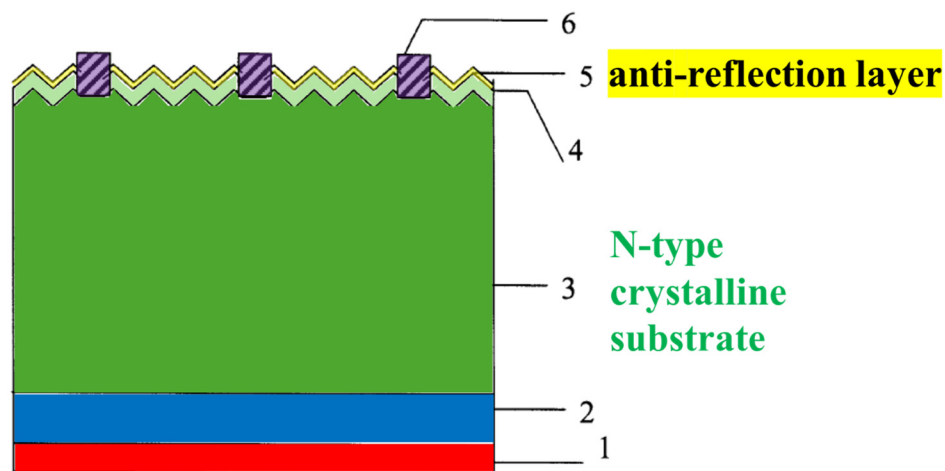
7. Claim 14

Claim 14 depends from claim 9. Petitioner incorporates Section X.C.2. Li teaches claim 14. Li teaches the surfaces of the “high-quality **N-type monocrystalline [substrate] 3**...[are] *textured* by a standard industrial process.” Ex.1008- Li, 4, claim 2 (“surface textured N-type crystalline silicon.”). As Li assumes, a POSITA would have known what “standard industrial” texturing processes were. Li also teaches that the “*texturing* treatment [is used] to reduce light reflection and improve a light trapping effect, which is conducive to improving the photoelectric conversion efficiency of the cell.” *Id.*, 4. A POSITA would have understood the textured front surface is also shown in Li’s Figure by the jagged edges on the front side of the solar cell.



Ex.1008-Li, Fig.1. Ex.1003-Decl., ¶¶317-319.

Li further teaches forming “[a]n *anti-reflection film*...on the texturing surface to further improve the photoelectric conversion efficiency of the cell.” Ex.1008-Li, 4, claim 2. Li’s figure shows a solar cell with an **anti-reflection layer 5** over the textured front surface. The **anti-reflection layer** can be a material such as SiN or SiO₂. *Id.*, 2.



Ex.1008-Li, Fig.1. Ex.1003-Decl., ¶¶320-321.

Smith further teaches claim 14. *See* Section X.B.7. As discussed in Section X.C.1, a POSITA would have been motivated to modify Li to implement a Smith's manufacturing methods with a reasonable expectation of success, including texturing and anti-reflective coating methods (which were common features in solar cell manufacturing at the time). Ex.1003-Decl., ¶322.

8. Claim 15

Claim 15 depends from claim 9. Petitioner incorporates Section X.C.2. For the reasons discussed in Section X.B.8, the combination of Li, Gan, and Smith teaches claim 15. For the reasons discussed in Section X.C.1 and X.B.8, a POSITA would have been motivated to modify the combination of Li and Gan to implement Smith's in situ diffusion process with a reasonable expectation of success. Section X.C.1. Ex.1003-Decl., ¶323.

9. Claim 16

a. 16[pre]

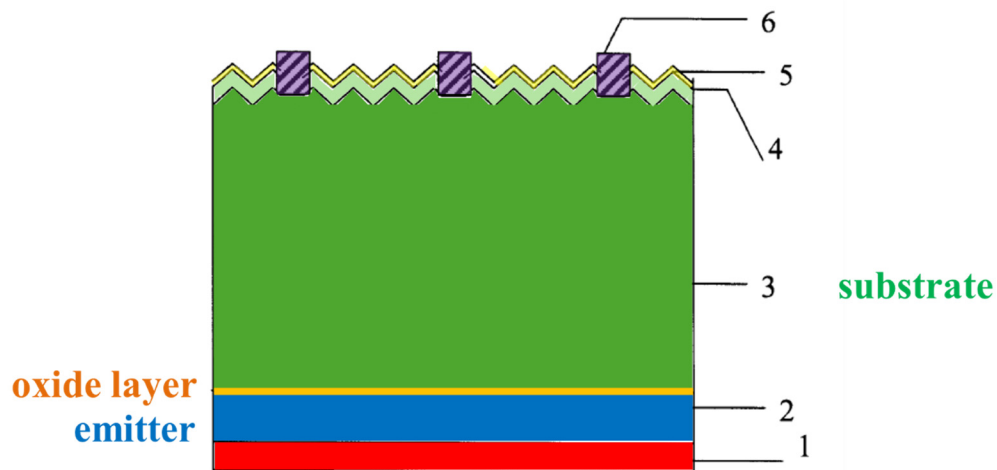
As discussed in Section X.C.2.a, Li, Gan, and Smith teach this element. Ex.1003-Decl., ¶325.

b. 16[a]-[b]

The combination of Li and Gan teaches these elements. As discussed in Sections X.C.2.b and X.A.2.b, Li teaches forming a backside, silicon emitter, and

Gan teaches forming a **P-type polysilicon emitter** that was useful for solar cells that had PN junctions on the back side. Ex.1003-Decl., ¶¶326-327.

Gan further teaches manufacturing a solar cell including the step of forming a “thermally grown interfacial oxide” (i.e., *oxide layer*) over the surface of a silicon substrate. Section X.A.7.b; Ex.1005-Gan, 245-246. As discussed in Section X.C.1, a POSITA would have been motivated to modify Li to manufacture a solar cell by *forming an oxide layer* (as taught by Gan) on the *back surface* of Li’s *substrate* and replacing Li’s emitter with a *polysilicon emitter* layer (as taught by Gan) with a reasonable expectation of success.



Ex.1008-Li, Fig.1; Ex.1005-Gan, 245-249. Ex.1003-Decl., ¶¶328-329.

c. 16[c]-[e]

As described in Sections X.C.2.d-f, the combination of Li, Gan, and Smith teaches these elements. Accordingly, the combination of Li, Gan, and Smith renders claim 16 obvious. Ex.1003-Decl., ¶¶324, 330-331.

10. Claim 17

Claim 17 depends from claim 16. Petitioner incorporates Section X.C.9. As discussed in Sections X.C.2.c-d, the combination of Li, Gan, and Smith teaches claim 17. Ex.1003-Decl., ¶332.

11. Claim 18

Claim 18 depends from claim 16. Petitioner incorporates Section X.C.9. As discussed in Sections X.C.5, the combination of Li, Gan, and Smith teaches claim 18. Ex.1003-Decl., ¶333.

12. Claim 19

Claim 19 depends from claim 16. Petitioner incorporates Section X.C.9. As discussed in Section X.C.7, Li and Smith teach claim 19. Ex.1003-Decl., ¶334.

13. Claim 20

Claim 20 depends from claim 19. Petitioner incorporates Section X.C.12. As discussed in Section X.C.7, Li and Smith teach claim 20. Ex.1003-Decl., ¶335.

XI. DISCRETIONARY DENIAL IS NOT WARRANTED

A. *General Plastics*

Petitioner has diligently and independently prepared this Petition in response to PO's recent patent infringement complaint against Petitioner. That complaint is part of an ongoing litigation campaign by PO. In response to another, earlier-filed lawsuit in this campaign, another accused infringer—CSI—filed a separate IPR petition challenging claims 9-20 of the '053 patent. There is no basis for discretionarily denying this Petition based on CSI's earlier-filed petition because no relationship exists between Petitioner and CSI, this Petition challenges *all* claims instead of a subset, minimal time separates the two petitions, and both petitions are timely, independent responses to PO's litigation activities. As detailed below, each *General Plastics* factor weighs against discretionary denial or is neutral at best. *General Plastics Industrial Co. v. Canon Kabushiki Kaisha*, IPR2016-01357, Paper 19, at 9-10 (P.T.A.B. Sept. 6, 2017).

Factor 1 weighs strongly against denial. Petitioner did not file the previous petition directed to the same patent. Nor is there any current relationship or communication about the asserted patents between Petitioner and CSI. Under these circumstances, discretionary denial is unwarranted unless supported by the other factors or if a “significant relationship” exists between the filers. *Illumina v. Ravgen*,

IPR2021-01271, Paper 12, at 14-15 (P.T.A.B. Jan. 26, 2022). Here there is no relationship—let alone a significant one—between CSI and Petitioner. Petitioner and CSI are competitors. The fact that Maxeon has brought district court actions against both Petitioner and CSI does not support considering them related filers for purposes of discretionary denial. *Id.*, 16-17; *Signify N. Am. Corp. v. Cao Lighting, Inc.*, IPR2023-00214, Paper 4, 21 (P.T.A.B. June 15, 2023) (factor 1 “strongly weighs against discretionary denial” when subsequent petitioner has no relationship to first filer).

Factor 2 is neutral. When the second petition is filed by a different entity, as here, this “factor is inapplicable...and, therefore, is neutral.” *Videndum Production Sols., Inc. v. Rotolight Ltd.*, IPR2023-01218, Paper 9, 11-12 (P.T.A.B. Jan. 25, 2024).

Factor 3 weighs against denial. PO has not submitted a preliminary response to CSI’s petition, nor has the Board issued an institution decision on CSI’s petition. Petitioner cannot have tailored its petition to either PO’s arguments in the first petition or reasoning by the Board. Thus, this factor weighs against denial. *Illumina*, Paper 12, 22-23.

Factors 4-5 weigh against denial. Petitioner’s timeliness in filing this petition after being accused of patent infringement strongly weighs against denial.

Since learning of Maxeon’s complaint, Petitioner moved expeditiously (and independently of CSI) to file this petition. Where the PO sues multiple independent entities, “a few month gap between the first and the [second] petition is not unreasonable,” even if Petitioner should have known about the prior art cited in CSI’s petition. *Id.* Approximately one month separates CSI’s petition and this Petition even though Maxeon sued CSI a month before Petitioner. Additionally, these factors should be given less weight because Petitioner is a different party than the earlier petitioner. *Illumina*, Paper 12, 20.

Factors 6-7 weigh against denial. The Board has adequate resources to timely address this Petition. Considering this Petition now will allow the Board to develop relevant substantive knowledge and minimize the resources needed to consider Petitioner’s and CSI’s distinct grounds. *Signify*, Paper 4, 23-24.

Moreover, “[d]enial of the Petition...w[ould] prejudice the Petitioner in this proceeding should the [CSI] Petition[] be resolved by settlement.” *Lowes Cos. Inc. v. Nichia Corp.*, IPR2017-02011, Paper 13, 19 (PTAB Mar. 12, 2018). This potential prejudice weighs against denial. *Samsung Elecs. Co. v. Iron Oak Techs., LLC*, IPR2018-01554, Paper 9, 29 (PTAB Feb. 13, 2019).

Finally, the Board has recognized that discretionary denial is inappropriate when, as here, the filing of “multiple petitions...against the same patent is a direct

result of Patent Owner’s litigation activity.” *Samsung*, IPR2018-01554, Paper 9, 29,

31. Accordingly, discretionary denial in view of CSI’s Petition is improper.

B. 35 U.S.C. §325(d)

Discretionary denial under 35 U.S.C. §325(d) is unwarranted because each *Advanced Bionics* factor weighs against denial. *Advanced Bionics v. MED-EL*, IPR2019-01469, Paper 6, 8-9 (P.T.A.B. Feb. 13, 2020).

Advanced Bionics factor 1 weighs against denial because this Petition presents prior art and arguments that were not previously considered. References introduced in this Petition—Froitzheim, Li, and Gan—were not disclosed or considered during prosecution. These references provide teachings that the Examiner found were not before the Office during prosecution. *See* Sections VI.B, X.A.1, X.C.1.

Although the examiner considered Smith, this Petition merely uses Smith for its disclosed routine processing steps. During prosecution, Applicant distinguished Smith for disclosing “backside contact” cells. *See* Ex.1002-USP053FH, 155. Applicant did not dispute that Smith disclosed the recited processing steps. Likewise, the Reasons for Allowance discussed the structure that resulted from Applicant’s claimed methods and made no indication that the fabrication steps were new or non-obvious. *See* Ex.1002-USP053FH, 250. Thus, this Petition’s arguments are materially different from the arguments before the examiner.

Even if *Advanced Bionics* factor 2 applies (it does not), it weighs against denial. This Petition presents additional evidence—Dr. Holman’s declaration and other evidence regarding the scope of the prior art and knowledge of a POSITA—that was not previously before the Office. This evidence contextualizes the prior art in this Petition and explains why this art renders the Challenged Claims unpatentable. It thus weighs against denial. *TwinStrand Biosciences, Inc. v. Huardant Health, Inc.*, IPR2022-01400, Paper 9, 11 (P.T.A.B. Feb. 8, 2023).

C. *Fintiv*

No *Fintiv* factor favors discretionary denial. *Apple Inc. v. Fintiv, Inc.*, IPR2020-00019, Paper 15 (P.T.A.B. May 13, 2020). Petitioner filed this Petition expeditiously after Maxeon filed suit in district court. Petitioner’s response to the complaint is not due until November 22, 2024, and there is no current case schedule or trial date in the litigation. This Petition also presents compelling merits, favoring institution.

XII. CONCLUSION

The Challenged Claims are rendered obvious by the foregoing grounds. Petitioner requests institution of *inter partes* review and cancellation of the Challenged Claims.

U.S. Patent No. 8,878,053
Petition for *Inter Partes* Review
Case No. IPR2024-01199

Respectfully submitted,

By: /David L. Cavanaugh/
David L. Cavanaugh
Registration No. 36,476

Counsel for Petitioner

APPENDIX OF CLAIMS

Claim 1	
Element	Claim Language
1[pre]	A method of fabricating 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 method comprising:
1[a]	forming a layer of polysilicon over a back surface of an N-type silicon substrate on the backside of the solar cell;
1[b]	forming a P-type dopant source over the layer of polysilicon;
1[c]	forming a capping layer over the P-type dopant source;
1[d]	diffusing P-type dopants from the P-type dopant source to the layer of polysilicon to form a backside junction with the N-type silicon substrate;
1[e]	diffusing N-type dopants into a front surface of the N-type silicon substrate; and

Claim 1	
Element	Claim Language
1[f]	forming a metal contact on the front side of the solar cell, wherein the metal contact is electrically coupled to the N-type silicon substrate.

Claim 2
The method of claim 1 wherein the P-type dopant source comprises borosilicate glass.

Claim 3
The method of claim 1 wherein diffusing N-type dopants into the front surface of the N-type silicon substrate includes forming an N-type dopant source over the N-type silicon substrate and diffusing N-type dopants from the N-type dopants source into the N-type silicon substrate.

Claim 4
The method of claim 3 wherein the N-type dopant source comprises phosphorus doped silicon dioxide.

Claim 5

The method of claim 1 further comprising:

texturing the front surface of the N-type silicon substrate; and

forming an antireflective layer over the textured front surface of the N-type silicon substrate.

Claim 6

The method of claim 5 wherein the antireflective layer comprises silicon nitride.

Claim 7

The method of claim 1 wherein the diffusion of P-type dopants from the P-type dopant source to the layer of polysilicon and the diffusion of N-type dopants into the front surface of the N-type silicon substrate are performed in situ.

Claim 8

The method of claim 1 wherein the capping layer comprises undoped silicon dioxide.

Claim 9	
Element	Claim Language
9[pre]	A method of fabricating a solar cell comprising:
9[a]	forming a layer of polysilicon over a back surface of a silicon substrate;
9[b]	forming a first dopant source layer over the layer of polysilicon;
9[c]	diffusing dopants from the first dopant source layer to the layer of polysilicon to form a backside junction with the silicon substrate;
9[d]	diffusing dopants into a front surface of the silicon substrate, the front surface of the silicon substrate facing the sun during normal operation; and
9[e]	forming a metal contact on the front surface of the silicon substrate, wherein the metal contact is electrically coupled to the silicon substrate.

Claim 10

The method of claim 9 wherein the first dopant source layer comprises P-type dopants.

Claim 11

The method of claim 9 wherein the first dopant source layer comprises borosilicate glass.

Claim 12

The method of claim 9 wherein diffusing dopants into the front surface of the silicon substrate comprises forming a second dopant source layer over the silicon substrate and diffusing dopants from the second dopant source layer into the silicon substrate.

Claim 13

The method of claim 12 wherein the second dopant source layer comprises phosphorus doped silicon dioxide.

Claim 14
The method of claim 9 further comprising: texturing the front surface of the silicon substrate; and forming an antireflective layer over the textured front surface of the silicon substrate.

Claim 15
The method of claim 9 wherein the diffusion of dopants from the first dopant source layer to the layer of polysilicon and the diffusion of dopants into the front surface of the silicon substrate are performed in situ.

Claim 16	
Element	Claim Language
16[pre]	A method of fabricating a solar cell comprising:
16[a]	forming an oxide layer over a back surface of a silicon substrate;
16[b]	forming a layer of polysilicon over the oxide layer;
16[c]	diffusing dopants into the layer of polysilicon to form a backside junction with the silicon substrate;

Claim 16	
Element	Claim Language
16[d]	diffusing dopants into a front surface of the silicon substrate, the front surface of the silicon substrate facing the sun during normal operation; and
16[e]	forming a metal contact on the front surface of the silicon substrate, wherein the metal contact is electrically coupled to the silicon substrate.

Claim 17
The method of claim 16 wherein diffusing dopants into the layer of polysilicon to form the backside junction with the silicon substrate comprises: forming a first dopant source layer over the layer of polysilicon; and diffusing dopants from the first dopant source layer into the layer of polysilicon.

Claim 18
The method of claim 16 wherein diffusing dopants into the front surface of the silicon substrate comprises forming a second dopant source layer over the silicon

Claim 18

substrate and diffusing dopants from the second dopant source layer into the silicon substrate.

Claim 19

The method of claim 16 further comprising:
texturing the front surface of the silicon substrate.

Claim 20

The method of claim 19 further comprising:
forming an antireflective layer over the textured front surface of the silicon substrate.

CERTIFICATE OF COMPLIANCE

I hereby certify that the foregoing, Petition for *Inter Partes* Review, contains 13,993 words as measured by the word processing software used to prepare the document, in compliance with 37 C.F.R. §42.24(d), excluding the parts of the Petition exempted from the word count by 37 C.F.R. §42.24(a)(1).

/Gilbert T. Smolenski/
Gilbert T. Smolenski
Registration No. 78,549

CERTIFICATE OF SERVICE

Pursuant to an agreement between Petitioner and Patent Owner, I hereby certify that, on August 8, 2024, I caused a true and correct copy of the following materials:

- Petition for *Inter Partes* Review of U.S. Patent No. 8,878,053
- Appendix of Claims
- Petitioner's Table of Exhibits
- Exhibits 1001-1010, 1013-1036, 1039-1040, 1042-1043, 1045-1047, 1049-1054, 1056-1062
- Certificate of Compliance Regarding Word Count
- Fee Authorization
- Power of Attorney

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Petitioner’s Table of Exhibits

No.	Description
1001	U.S. Patent No. 8,878,053 B2 (“USP053”)
1002	File History for U.S. Patent No. 8,878,053 B2 (App. No. 13/495,577) (“FH053”)
1003	Declaration of Dr. Zachary Holman Regarding U.S. Patent No. 8,878,053 B2
1004	EP1732142A1 to Froitzheim (“Froitzheim”)
1005	Gan and Swanson, <i>Polysilicon Emitters for Silicon Concentrator Solar Cells, IEEE Conference on Photovoltaic Specialists</i> , Vol. 1, Pages 245-240 (1990) (“Gan”)
1006	WO 2009/094575 A2 (“Borden-575”)
1007	U.S. Patent No. 6,998,288 to Smith (“Smith”)
1008	CN 1949545A to Li (Translation) (“Li”)
1009	Translation Declaration for Li
1010	Zachary C. Holman, <i>Electron Transport in Amorphous Silicon</i> (May 2005) (Thesis Presented to The Division of Mathematics and Natural Sciences, Reed College) (“Holman-Thesis”)
1011	Reserved
1012	Reserved
1013	Declaration of June Munford
1014	Complaint for Patent Infringement, <i>Maxeon Solar Pte. Ltd. v. Hanwha Solutions Corp., et al.</i> , Civil Action No. 2:24-cv-262 (E.D. Tex. Apr. 19, 2024), ECF No. 1 (“Complaint”)
1015	U.S. Patent No. 7,468,485 to Swanson (“Swanson”)
1016	R. J. Komp, <i>Practical Photovoltaics Electricity From Solar Cells</i> , 3rd Ed. (2002) (“Komp”)
1017	BP Solar Global Marketing, BP-MSX-120, 120-Watt Multicrystalline Photovoltaic Module (“BP-MSX-120”)
1018	J. Nelson, <i>The Physics of Solar Cells</i> , Imperial College Press (2003) (“Nelson”)
1019	T. Krygowski, A. Rohatgi, D. Ruby, <i>Simultaneous P and B Diffusion, In-Situ Surface Passivation, Impurity Filtering and Gettering for High-Frequency Silicon Solar Cells</i> , SAND-97-2620C; CONF-970953- (“Krygowski”)

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1021	J. Gordon, <i>Solar Energy the State of the Art</i> , ISES (2001) (“Gordon”)
1022	U.S. Patent No. 6,262,359 to Meier (“Meier”)
1023	U.S. Patent No. 4,525,593 to Yablonovitch (“Yablonovitch”)
1024	WO 2009/094578 A2 (“Borden-578”)
1025	U.S. Patent No. 4,665,277 to Sah (“Sah”)
1026	D. Chapin et al., <i>A New Silicon P-N Junction Photocell for Converting Solar Radiation into Electrical Power</i> , J. Appl. Phys. 25, 676 (1954) (“Chapin”)
1027	W. Shockley, H. J. Queisser, <i>Detailed Balance Limit of Efficiency of pn Junction Solar Cells</i> , J. Appl. Phys. 32, 510 (1961) (“Shockley”)
1028	A. Metz, R. Meyer, B. Kuhlmann, M. Grauvogl, R. Hezel, <i>18.5% Efficient First-Generation MIS Inversion-Layer Silicon Solar Cells</i> , 26th PVSC (1997) (“Metz”)
1029	D. De Ceuster, P. Cousins, D. Rose, D. Vicente, P. Tipones, W. Mulligan, <i>Low Cost, High Volume Production of >22% efficiency silicon solar cells</i> , 22nd European Photovoltaic Solar Energy Conference, 3-7 September 2007, Milan, Italy, pp. 816-819 (“De-Ceuster”)
1030	J. Benick, J. Rentsch, Ch. Schetter, C. Voyer, D. Biro, R. Preu, <i>PECVD PSG as a Dopant Source for Industrial Solar Cells, Presented at the 21st European Photovoltaic Solar Energy Conference</i> , September 4-8, 2006, Dresden (2CV.4.26) (“Benick”)
1031	JP07-106611 to Okayasu (Translation) (“Okayasu”)
1032	Translation Declaration for Okayasu
1033	Robert F. Pierret, <i>Semiconductor Device Fundamentals</i> , Addison Wesley Longman (Part I) (1996) (“Pierret”)
1034	A. I. A. Rahim, C. D. Marsh, P. Ashburn, G. R. Booker, <i>Impact of Ex-Situ and In-Situ Cleans on the Performance of Bipolar Transistors With Low Thermal Budget In-Situ Phosphorus-Doped Polysilicon Emitter Contacts</i> , IEEE

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1036	E. Yablonovitch, T. Gmitter, R. M. Swanson, Y. H. Kwark, <i>A 720 mV open circuit voltage SiO_x:c-Si:SiO_x double heterostructure solar cell</i> , Appl. Phys. Lett. 47, 1211–1213 (1985) (“Yablonovitch-1985”)
1037	Reserved
1038	Reserved
1039	File History of U.S. Patent App. No. 14/504,771 (“771FH”)
1040	U.S. Patent No. 8,222,516 B2 (“USP516”)
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1047	G. R. Wolstenholme, N. Jorgensen, P. Ashburn, G. R. Booker, <i>An investigation of the thermal stability of the interfacial oxide in polycrystalline silicon emitter bipolar transistors by comparing device results with high-resolution electron microscopy observations</i> , J. Appl. Phys. 61, 225–233 (1987) (“Wolstenholme”)
1048	Reserved
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No.	Description
1050	N. G. Tarr, <i>A polysilicon emitter solar cell</i> , IEEE Electron Device Letters, vol. 6, no. 12, pp. 655-658, Dec. 1985 (“Tarr”)
1051	R. M. Swanson, <i>Point Contact Solar Cells: Modeling and Experiment</i> , Solar Cells, 17, pp. 85-118 (1986) (“Swanson-1986”)
1052	U.S. Patent No. 4,158,591 to Avery (“Avery”)
1053	U.S. Patent No. 5,899,804 to Schlosser (“Schlosser”)
1054	U.S. Patent No. 7,144,751 to Gee (“Gee”)
1055	Reserved
1056	WO 2006/097303 A1 (“Agostinelli”)
1057	P.V. Meyers, R. Kee, C. Wolden, L. Raja, V. Kaydanov, T. Ohno, R. Collins, M. Aire, J. Kestner, A. Fahrenbruch, <i>Atmospheric Pressure Chemical Vapor Deposition of CdTe for High Efficiency Thin Film PV Devices</i> , NREL Annual Report 26 January 1998 – 25 January 1999 (Sept. 1999) (“NREL-1999”)
1058	R. M. Swanson, R. A. Sinton, <i>High-Efficiency Silicon Solar Cells, Advances in Solar Energy: An Annual Review of Research and Development</i> , vol. 6. Chapter 4 (1990) (“Swanson-1990”)
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