

UNITED STATES PATENT AND TRADEMARK OFFICE
BEFORE THE PATENT TRIAL AND APPEAL BOARD

MUNDRA SOLAR PV LTD. AND ADANI SOLAR USA INC.,
Petitioners,

v.

TRINA SOLAR CO., LTD.,
Patent Owner.

Case No. IPR2025-00186
U.S. Patent No. 9,722,104

PATENT OWNER'S PRELIMINARY RESPONSE

TABLE OF CONTENTS

	Page
I. INTRODUCTION	1
II. ARGUMENT	2
A. The '104 Patent's Invention	3
B. The Petition Failed to Establish a Reasonable Likelihood of Success For Ground 1 (Jin and Feldmann)	8
1. The Purported Prior Art	8
a. Jin (Ex. 1009).....	8
b. Feldmann (Ex. 1012)	11
2. Jin And Feldmann Do Not Render Claim 1 Obvious	14
C. The Petition Failed to Establish a Reasonable Likelihood of Success For Ground 2 (Chang and Jin).....	22
1. Chang (Ex. 1013)	23
2. Chang and Jin Do Not Render Claim 1 Obvious.....	24
III. CONCLUSION.....	31

I. INTRODUCTION

Patent Owner Trina Solar Co., Ltd. submits this preliminary response to Mundra Solar PC Ltd. and Adani Solar USA Inc.'s Petition for *Inter Partes* Review (Paper 1, the "Petition") of U.S. Patent No. 9,722,104 (the "'104 Patent").

The Petition has not established that there is a reasonable likelihood of success in connection with any challenged claim. While Petitioners raise six Grounds, only two Grounds (Nos. 1 and 2) purport to address the single independent claim of the '104 Patent. And, as to those Grounds, there are numerous fundamental differences between the '104 Patent's claims and the prior art references on which the Petition here relies (Jin, Feldmann, and Chang).

Specifically, the '104 Patent discloses – and the claims all require – a TOPCon solar cell with an isolation portion that separates the emitter and back side conductive layers and excludes the tunnel layer. Jin does not disclose a TOPCon solar cell or the claimed "tunnel layer." While Feldmann and Chang are TOPCon solar cells, they each form the emitter and back side conductive layers on opposite sides of the semiconductor substrate and thus neither disclose nor support the isolation portion claimed by the '104 Patent.

In fact, the art Petitioners rely upon contradicts Petitioners' arguments and teaches that it should not be modified or combined in the manner Petitioners' proposes. For example, Feldmann expressly teaches the requirement of a

metallization layer (rather than point contacts) and states that the '104 Patent's claimed insulating layer is "inconsistent" with Feldmann's invention. Like Feldmann, Chang discloses a solar cell where the emitter and back side conductive layers are on opposite sides of the semiconductor substrate. Thus, Chang specifically teaches that a further isolation portion is not required and extols the benefits of simplicity and cost savings that it achieves by omitting such an isolation portion. In contrast, Jin is not a TOPCon solar cell, it does not include a tunnel layer, and it is inconsistent with the Feldmann/Chang structures. And even were a POSITA motivated to attempt to combine Jin with Feldmann or Chang, the resulting combination would not exclude the tunnel oxide layer from an isolation portion as required by the challenged claims.

Petitioners ignore the express teachings of the references and rely on nothing more than hindsight in an attempt to cobble together a combination that might meet the claim limitations. Because Petitioners cannot meet their burden to prove that the Jin/Feldmann or Chang/Jin combinations render obvious claim 1 of the '104 Patent, none of Petitioners' Grounds invalidate any of the challenged claims.

II. ARGUMENT

The '104 Patent presents one independent claim. While the Petition raises six Grounds, only two of those Grounds (numbers 1 and 2) purport to address independent claim 1. Because the Petition fails to establish a reasonable likelihood

that either Ground renders claim 1 obvious, the Board should deny the Petition and need not address the other five Grounds directed to the dependent claims.

A. The '104 Patent's Invention

The '104 Patent relates to “a solar cell and a method for manufacturing the same.” (Ex. 1001, 1:19-21.) As the patent explains, a solar cell “generates electric power from solar energy...” (*Id.* 1:25-26). Prior art solar cells “include[] substrates made of semiconductors having different conductive types, such as a p type and an n type, a second conductive type semiconductor region (or emitter layer), and electrodes respectively connected to the substrates and the second conductive type semiconductor region.” (*Id.*, 1:30-35). This forms a “p-n junction” at the interface of the substrate and the second conductive type semiconductor region.” (*Id.* 1:35-37).

When light strikes the solar cell, “a plurality of electron-hole pairs are generated from the semiconductors.” (*Id.*, 1:38-39). The electrons and holes move toward the n type and p type semiconductor regions, respectively, and are collected by electrodes electrically connected to the substrates and the second conductive type semiconductor region. (*Id.* 1:40-47). “The electrodes are connected by lines, thereby obtaining power.” (*Id.* 1:47-48).

The solar cells of the '104 Patent include a tunnel layer between the first surface of the semiconductor substrate and the first conductive type semiconductor

region. (*Id.* 1:52-56). “Such a tunnel layer **160** may generate a tunneling effect. More specifically, the tunnel layer **160** may function as a kind of barrier for electrons and holes.” (*Id.* 7:60-62). “That is, the tunnel layer **160** may not transmit minority carriers. After the minority carriers are accumulated in a portion neighboring the tunnel layer **160**, only majority carriers having energy of a specific level or higher may pass through the tunnel layer **160**. The majority carriers having energy of a specific level or higher may easily pass through the tunnel layer **160** by a tunneling effect.” (*Id.* 7:63-8:2).

The tunnel layer increases efficiency by preventing recombination of the electron and holes within semiconductor region and solar cells with such a tunnel layer can be referred to as “TOPCon” or “Tunnel Oxide Passivated Contact.” The ’104 Patent describes an improved TOPCon structure and method of manufacture. Specifically, the ’104 Patent describes a process where “tunnel layer **160** can be easily formed because a separate patterning process is not required.” (*Id.* 7:57-58).

In the method of the ’104 Patent, “the first conductive type semiconductor region **170** may be formed on the back surface of the tunnel layer **160**....” (*Id.* 8:47-49). As a result of this manufacturing process, the inventors observed that the first conductive type semiconductor region **170** might contact second conductive type semiconductor region **120**, which can create a short-circuit where the electrons and

holes recombine (rather than be collected) and, thus, reduce the efficiency of the solar cell:

That is, when the second conductive type semiconductor region **120** is formed, the impurities of the second conductive type may be diffused into the side of or the edge of the back surface of the semiconductor substrate **100**, and thus the first conductive type semiconductor region **170** and the second conductive type semiconductor region **120** may be unwantedly short-circuited in the side of or the edge of the back surface of the semiconductor substrate **100**.

(*Id.* 13:24-35).

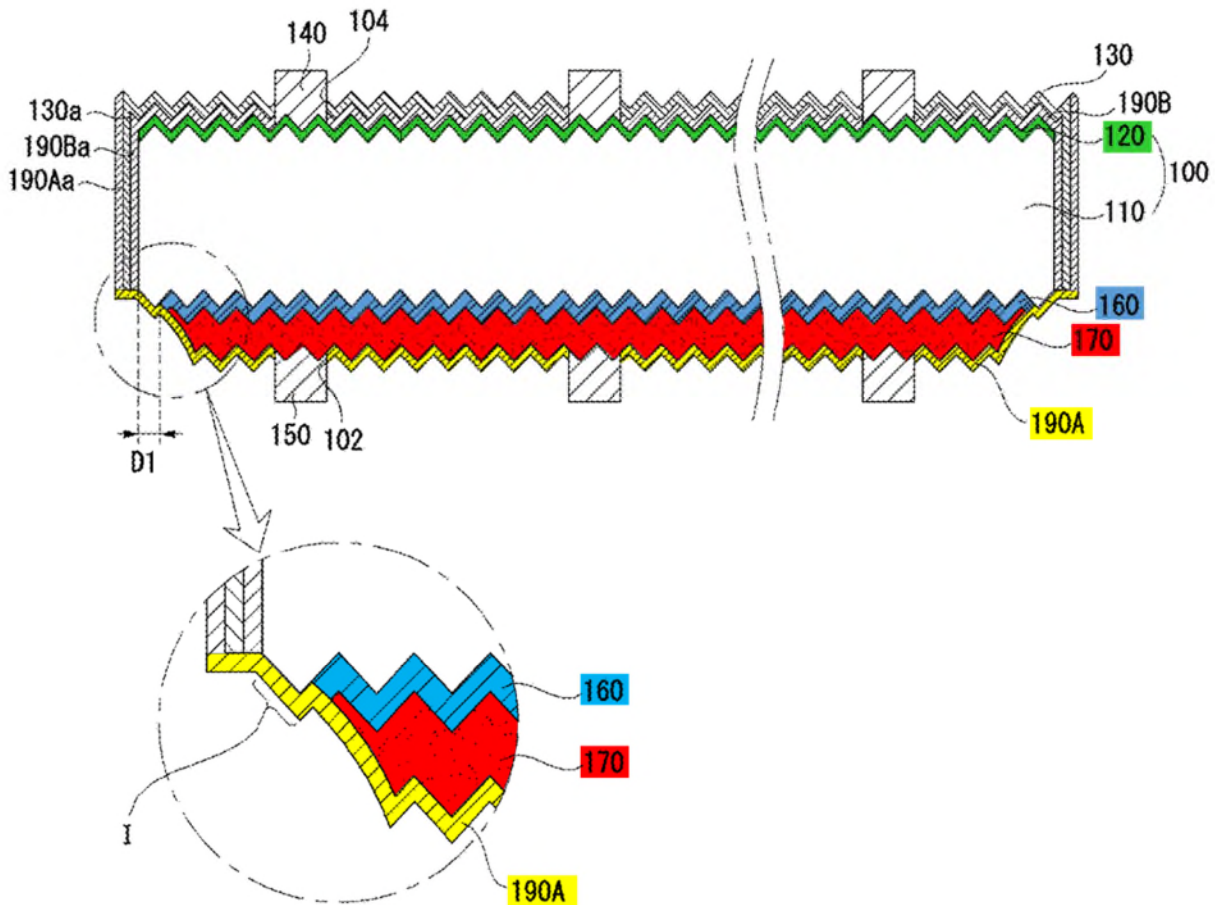
The inventors developed and claimed a solution to prevent this unwanted short-circuit – an “isolation portion” that prevents contact between the opposite conductive type semiconductor regions. “In the present embodiment, such a problem can be fundamentally prevented by removing the first conductive type semiconductor region **170** from the edge of the back surface of the semiconductor substrate **100**.” (*Id.* 13:31-35). A key part of the invention of the ’104 Patent is that the tunnel layer is also excluded from this isolation portion. (*Id.* 7:52-54 (“Such a tunnel layer **160** may be generally formed in portions other than an isolation portion I in the back surface of the semiconductor substrate **100**.”))

The '104 Patent illustrates an inventive TOPCon solar cell as shown in FIG. 2. The solar cell may include base region **110** and emitter region **120** [shown in green]. In the claims of the '104 Patent, silicon substrate **100** and emitter region **120** are of opposite conductive types (*e.g.*, if base region **110** is n-type then emitter region **120** is p-type). “The second conductive type semiconductor region **120** having the second conductive type has a conductive type different from that of the base region **110** and may form an emitter region forming a pn junction along with the base region **110**.” (*Id.* 10:15-20). First conductive n-type semiconductor region **170** [shown in red] is at the opposite side of the solar cell. Tunnel layer **160** [shown in blue] separates first conductive type semiconductor region **170** from base region **110**.

Because, as explained above, the manufacturing process of the '104 Patent can result in second conductive type semiconductor region **120** extending along the sides of the solar cell (not shown in FIG. 2), the inventors included an isolation portion **I** (shown in the magnified portion of FIG. 2) that prevents contact by excluding both tunnel layer **160** and first conductive type semiconductor region **170**. Importantly, “tunnel layer **160** may be generally formed in portions other than an isolation portion **I** in the back surface of the semiconductor substrate **100**” and, thus,

is also excluded in this isolation portion. (*Id.* 7:52-54; *see also* 12:66-13:15.) A first passivation film **190A** [shown in yellow] covers at least the isolation portion.

FIG. 2



Relevant to this preliminary response, the claims all require an “isolation portion [that] excludes the tunnel layer and the first conductive type semiconductor region....” (Ex. 1001, 38:26-27.)

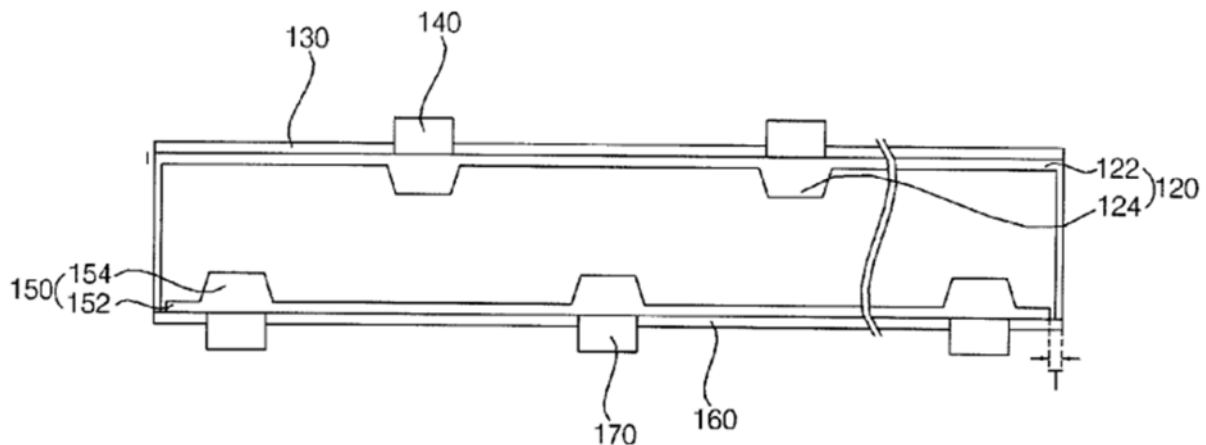
B. The Petition Failed to Establish a Reasonable Likelihood of Success For Ground 1 (Jin and Feldmann)

1. The Purported Prior Art

a. Jin (Ex. 1009)

Jin claims priority to a foreign application filed September 7, 2011. (Ex. 1009). Jin does not disclose a TOPCon solar cell or include a TOPCon oxide layer. Instead, Jin describes an old-fashioned solar cell where regions of a semiconductor substrate (110) are doped with different impurities to create “an emitter layer **120** disposed on one surface of the substrate **110**... [and] a back surface field layer **150** on the other surface of the substrate **110**...” Emitter 120 and back surface field layer 150 are of opposite conductive types. (*Id.* [0026]).

FIG. 3



The purpose of Jin’s invention is to include shallow doping areas in the emitter and back surface field layers. As Jin teaches, “it is very important to improve the efficiency” of solar cells (*id.* [0006]) and “[t]o achieve this and other objectives...

the emitter [region] includes at least a first shallow doping area and the back surface field layer includes at least a second shallow doping area....” (*Id.* [0008]).

Jin recognized a tradeoff between the amount of impurities in the doped regions and the efficiency of the solar cell. As Jin explained, “where photons are converted to electron-hole pairs, it is advantageous to have a relatively low impurity density” but “where separated electrons or holes move toward the... finger lines..., it is more desirable to have a relatively high impurity density to reduce contact resistance.” (*Id.* [0031]).

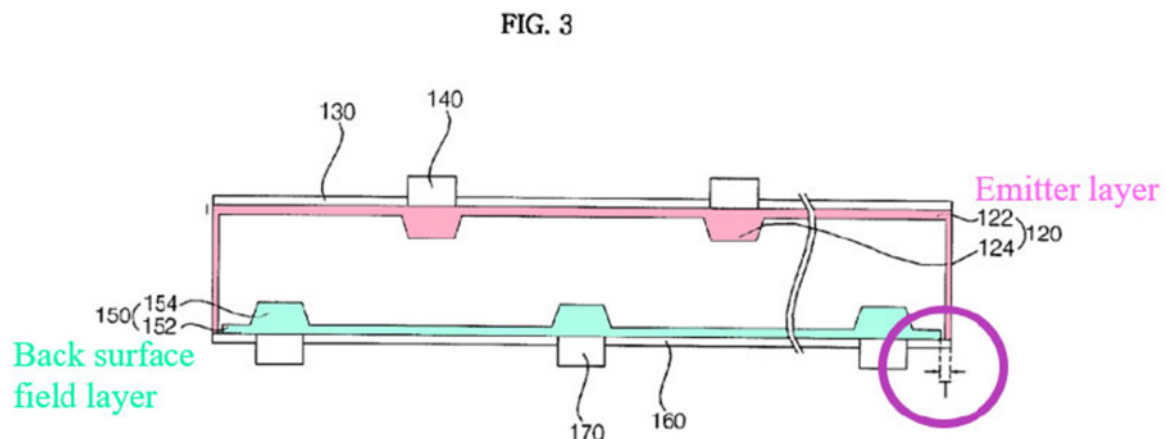
Jin taught a POSITA¹ to balance these tradeoffs by including a shallow doped region where the photons are converted into electron-hole pairs (most of the solar

¹ Petitioners contend that a POSITA “would have been someone with an advanced degree involving the disciplines of electrical engineering, applied physics, chemistry, or material science, and at least two years of experience designing, developing, or researching in the field. Alternatively, that person would have had a bachelor’s degree in electrical engineering, applied physics, or material science, and at least three years of experience designing, developing, or researching in the field.” (Petition, 4-5). For purposes of this preliminary response, Patent Owner does not dispute that standard.

cell surface) and a deeper doped region below the contacts to reduce contact resistance:

[S]ince the doping density of the third area **154** of the back surface field layer **150** is larger than that of the fourth area **152**, contact resistance between the third area **154** and the rear finger lines **170** is reduced, and since the fourth area **152** is formed throughout the rear surface of the substrate **110**, recombination of electrons and holes may be effectively prevented or reduced. Therefore, since loss due to recombination of electrons and holes is reduced and at the same time, transfer of electrons and holes generated by the photovoltaic effect to the rear finger lines **170** is further expedited, photovoltaic conversion efficiency of the solar cell **100** may be greatly improved.

(*Id.* [0043]). Figure 3 of Jin, which Petitioners annotated and relied upon, shows shallow doping areas (**152**) and thicker doping areas (**154**) in the back surface layer:

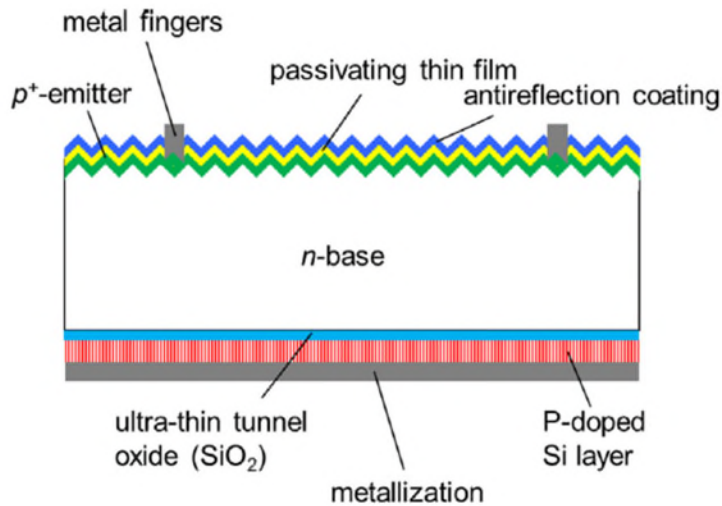


Jin reinforces to a POSITA the central importance of the shallow regions in the back surface field layer by having all of Jin's claims require that "the back surface field layer includes at least a second shallow doping area...." (*Id.* at claim 1 and claim 12).

Jin uses masks to form the doped regions within the substrate. (*Id.*, *e.g.*, [0077-0090]. In this way, Jin forms a gap T between back surface field (**150**) and the edge of substrate (**110**). (*Id.* [0057]). This gap is formed within the substrate and Jin does not disclose or suggest that its masks could be used to shape regions grown or deposited onto (not within) the substrate.

b. Feldmann (Ex. 1012)

In contrast to Jin, Feldmann teaches a novel and entirely different type of solar cell that "is based on an ultra-thin tunnel oxide (SiO₂) and a phosphorus-doped silicon layer." (Ex. 1012, Abstract). Feldmann teaches that this "significantly reduce the surface recombination at the metal-semiconductor interface." (*Id.*).



(*Id.* at 272 [original coloring]). As depicted, Feldmann’s “p⁺-emitter” is completely separate from the “P-doped Si layer” and, consequently, these doped layers are not short-circuited and there is no need for an additional isolation portion.

Feldmann named his new structure “TOPCon (Tunnel Oxide Passivated Contact)” and identified three prerequisites that “are to be met: (i) excellent interface passivation, (ii) efficiently doped layers to maintain the quasi-Fermi level separation in c-Si (high V_{oc}), and (iii) an efficient majority carrier transport (high FFs).” (*Id.* at 270).

Feldmann teaches that his “tunnel oxide is a vital part” of his invention and “that it is required to achieve excellent interface passivation for both open-circuit and maximum power point (MPP) conditions....” (*Id.* Abstract). “Notably, the tunnel oxide is crucial to obtain very high passivation quality, since lifetime samples solely passivated by an as-deposited Si layer or an annealed Si layer (red circles in Fig. 1) yield very low iV_{oc} values.” (*Id.* at 271). In contrast, “[t]he reduced

passivation quality of the unpassivated lifetime samples (without tunnel oxide) leads thus not only to a lower iV_{oc} but also to a reduced iFF of about 83%.” (*Id.*) “As expected, the V_{oc} of the solar cells with an unpassivated contact (without tunnel oxide layer) is drastically decreased to 638 mV due to a high $J_{ob}=593 \text{ fA/cm}^2$.” (*Id.* at 272).

As shown, Feldmann’s TOPCon solar cell has metal finger contacts on its front (sun) facing surface but does not have point contacts on the backside. Instead, Feldmann has a “metallization” layer across that surface. Feldmann teaches a POSITA that using such a metallization layer rather than point contacts increases the cell’s efficiency. (*Id.* at 272 (“While the passivated contact’s specific contact resistance takes a value of about $10 \text{ m}\Omega \text{ cm}^2$, its contribution to RS can be neglected since the rear is fully metallized. Thus, the relatively small loss in FF due to series resistance can be solely attributed to the solar cell’s front side.”).

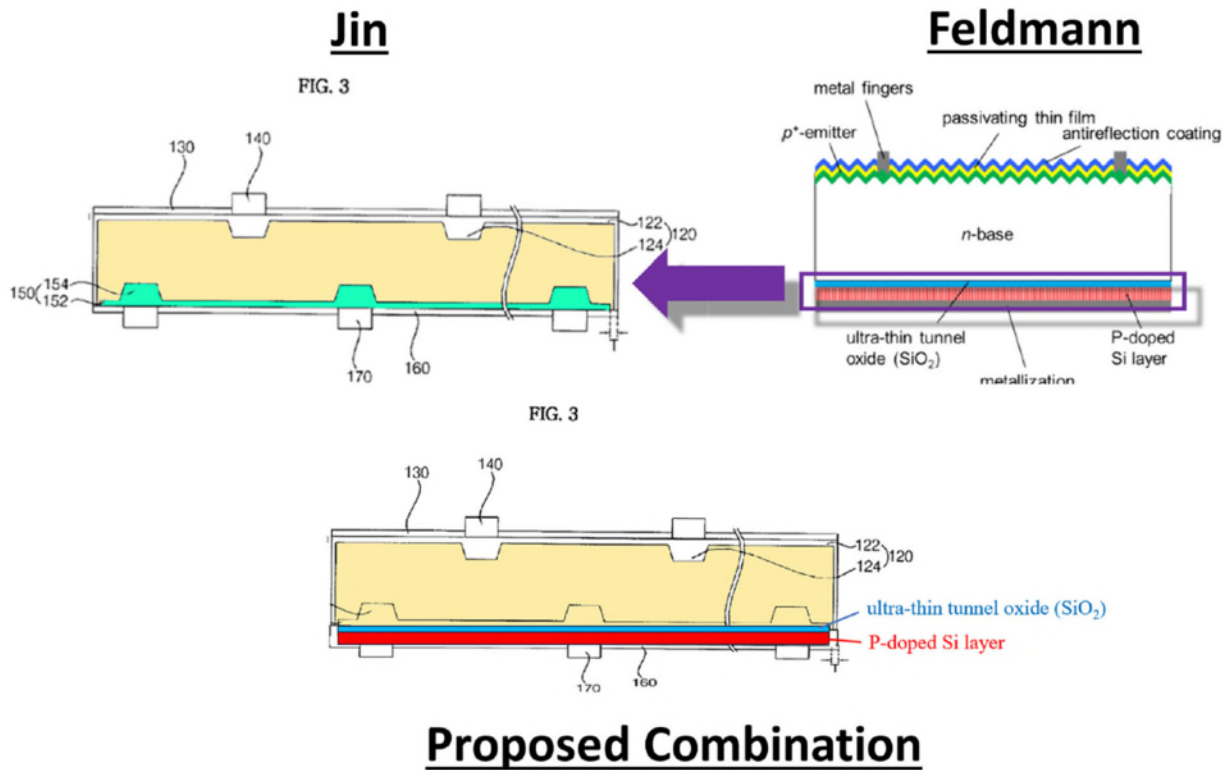
Feldmann further teaches that its metallization layer is important to Feldmann’s third “prerequisite” of high FFs. “Contrary to point contact rear side passivation schemes... its one-dimensional design facilitates processing (no structuring and alignment) and enables high FFs above 82% while maintaining a high V_{oc} .” (*Id.* at 274). To make the point clear, Feldmann explicitly criticizes earlier approaches such as PERL cells “which feature a thick dielectric layer with a low index of refraction” with openings through which metal contacts connect to the

doped region. As Feldmann explains, “the application of any insulating dielectric layer [between the metal and P-doped Si layer] would contradict the idea of our TOPCon structure and, thus, it would lose the inherent FF advantage of the one-dimensional junction design.” (*Id.* at 273).

2. Jin And Feldmann Do Not Render Claim 1 Obvious

Neither Feldmann nor Jin, alone or in combination, disclose the invention of the '104 Patent. For example, Jin is an old-fashioned, non-TOPCon solar cell. Jin lacks at least the claimed tunnel oxide and polysilicon layers, and its invention is the inclusion of shallow doped regions, which Jin teaches increase efficiency. Feldmann takes an entirely different approach. Rather than vary thickness of the back side layer to account for the point contacts, Feldmann describes a TOPCon solar cell with an “ultra-thin tunnel oxide” and “P-doped Si layer.” Feldmann does not disclose the '104 Patent’s claimed isolation portion and a central part of Feldmann’s invention is the use of a metallization layer that excludes a passivating film, rather than the passivation layer, openings, and electrodes claimed in the '104 Patent.

In Ground 1, Petitioners purport to arrive at the '104 Patent’s invention by picking and choosing pieces of Jin and Feldmann to combine. Specifically, Petitioners propose “substituting the diffused BSF layer 150 (green) of Jin with the phosphorous-doped polysilicon layer (red) of Feldmann along with the beneficial tunnel oxide layer (blue) on the backside of Jin’s solar cell substrate.” Petition, 24.



Petition, 25. This combination is nothing more than hindsight that ignores the express teachings of both Jin and Feldmann.

First, Jin teaches that by forming shallow areas **152** and more highly doped areas **154** on Jin’s back surface field **150**, “recombination of electrons and holes may be effectively prevented or reduced.” (Ex. 1009, [0043]). The proposed combination eliminates that benefit by replacing Jin’s back surface field with Feldmann’s P-doped Si layer, which has a uniform thickness. Neither the Petition nor Petitioners’ expert attempts to explain why a POSITA would modify Jin in such a manner as to eliminate the benefit of Jin’s invention.

Second, Petitioners do not explain why a POSITA would allegedly have sought to combine some, but not all, of Feldmann’s back side layer. For example,

Petitioners propose importing Feldmann’s ultra-thin tunnel oxide and P-doped Si layer, but not Feldmann’s metallization layer. Instead, Petitioners rely on Jin’s point-contact electrodes. But, Feldmann specifically criticizes prior art point contacts, such as in the older Jin patent, and teaches that “[c]ontrary to point contact rear side passivation schemes... [Feldmann’s] one-dimensional design facilitates processing (no structuring and alignment) and enables high FFs above 82% while maintaining a high V_{oc} .” (Ex. 1012 at 274). Neither Petitioners nor their expert provide any explanation – other than hindsight – why a POSITA would rely on Feldmann’s teaching to modify Jin to include Feldmann’s ultra-thin tunnel oxide and P-doped Si layer but would then ignore Feldmann’s teachings to use a metallization layer rather than point contacts.

Third, Petitioners’ combination adds an insulating dielectric layer to Feldmann’s back surface structure even though Feldmann expressly teaches that “the application of any insulating dielectric layer would contradict the idea of our TOPCon structure and, thus, it would lose the inherent FF advantage of the one-dimensional junction design.” (*Id.* at 273). Once again, neither Petitioners nor their expert even attempt to explain why a POSITA would have been motivated to ignore Feldmann’s instructions and attempt to make the proposed combination.

Fourth, Petitioners’ combination assumes that a POSITA would exclude Feldmann’s “vital” tunnel layer from a portion of the substrate. The petition presents

no reason why a POSITA would ignore Feldmann's teachings about the importance of the tunnel layer and instead choose, as Petitioners contend, to try to form "the gap T [that] would separate [not only] the edge of the polysilicon BSF.... [but also] oxide layer (blue) from the edge of the silicon substrate 110...." (Petition at 38). While the Petition cites ¶ 148 of Dr. Banerjee's Declaration (Ex. 1003), Dr. Banerjee merely parrots the petition, provides no further explanation, and does not support Petitioners' argument. In ¶ 148 Dr. Banerjee suggests it is necessary that gap T separate back surface field layer 150 and emitter layer 120 to "isolate[] and inhibit[] electrical shorting... caused by diffusion of dopants along the edges of substrate 110 when forming the BSF 150," but that does not support Petitioners' argument that a POSITA would also exclude the tunnel layer from this region.

In an entirely separate section of his declaration, Dr. Banerjee states "If the tunnel oxide layer were to extend to the edge, the exposed portions of the oxide could trap impurities and create negative fixed oxide charges, which could then create a p-type inversion in the n-type base substrate, leading to a leakage path to the p-type emitter on the front of the solar cell." (Ex. 1003, ¶ 116). Even if considered, this single, unsupported sentence is pure hindsight and insufficient to meet Petitioners' burden. Neither Petitioners nor their expert claim, let alone provide support in the prior art, that a POSITA would have known this *at the time of the invention of the '104 Patent*. To the contrary, as the Patent Office recognized during the prosecution

of a continuation of the '104 Patent, a novel part of the claimed invention is excluding the tunnel layer from the isolation portion. As explained in § II.C.1, during prosecution of U.S. Patent No. 10,014,419, which is a continuation of the '104 Patent, the Examiner allowed the claims, in part, because the prior art does not teach or render obvious forming an isolation portion from which the tunnel layer has been removed (and, thus, is excluded). (Ex. 1006 at 254). This is consistent with Feldmann's teaching that the tunnel layer is "vital" to his invention and his failure to suggest that the tunnel layer could be excluded from any portion of the solar cell. There is no motivation for a POSITA at the time of the invention of the '104 Patent to seek to exclude Feldmann's tunnel layer from the edge of the substrate.

Petitioners' proposed combination relies on hindsight to pick and choose what elements of each reference to include and which to ignore. This violates the Federal Circuit's instruction that the question of obviousness must be determined "from a fair reading of the prior art reference as a whole...." *In re Gordon*, 733 F.2d 900, 902 (Fed. Cir. 1984) (rejecting Patent Office determination that claim was obvious); *see also In re Enhanced Sec. Research, LLC*, 739 F.3d 1347, 1355 (Fed. Cir. 2014) (improper to "stitch together an obviousness finding from discrete portions of prior art references without considering the reference as a whole."); *In re Suong-Hyu Hyon*, 679 F.3d 1363, 1367 (Fed. Cir. 2012) ("It is impermissible within the framework of section 103 to pick and choose from any one reference only as much

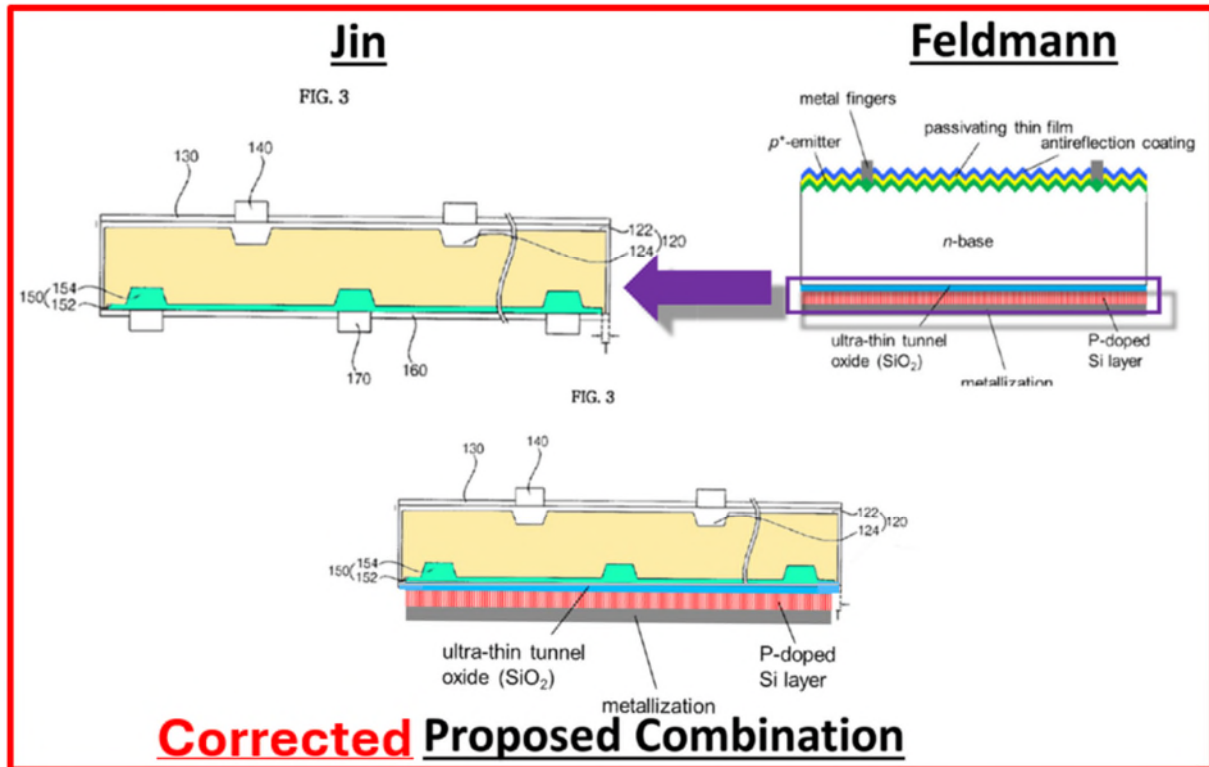
of it as will support a given position, to the exclusion of other parts necessary to the full appreciation of what such reference fairly suggests to one of ordinary skill in the art.” (quoting *In re Wesslau*, 353 F.2d 238, 241 (C.C.P.A. 1965)).

Considering Feldmann as a whole, a POSITA attempting to combine Jin and Feldmann would have been motivated to include Feldmann’s metallization layer because Feldmann taught this was necessary for the “prerequisite” of “high FFs.” (Ex. 1012 at 270). And given Feldmann’s teaching that “the application of any insulating dielectric layer would contradict the idea of our TOPCon structure and, thus, it would lose the inherent FF advantage of the one-dimensional junction design,” (*Id.* at 273) a POSITA would not have included Jin’s dielectric layer. Finally, even if a POSITA were to attempt to combine Jin’s gap T with Feldmann back side layer, they would have followed Feldmann’s teaching and would have had no motivation to exclude the tunnel layer from any isolation portion.

In contrast, Jin provides no teaching why a POSITA should include its point contacts (170) and no criticism of Feldmann’s metallization layer. Neither Petitioners nor their expert provide any explanation, other than hindsight, why a POSITA would ignore Feldmann’s clear teaching of the benefit of using metallization layer (and absence of an insulting layer) with his ultra-thin tunnel oxide and P-doped Si region, a POSITA would have included it any proposed combination. “It is impermissible within the framework of section 103 to pick and choose from

any one reference only so much of it as will support a given position, to the exclusion of other parts necessary to the full appreciation of what such reference fairly suggests to one of ordinary skill in the art”. *In re Hedges*, 783 F.2d 1038, 1041 (Fed. Cir 1986).

Thus, considering the teachings of the references as a whole as required by law and the Board’s rules, to the extent a POSITA would have been motivated to attempt to combine Jin and Feldmann, he or she would have included Feldmann’s metallization layer (because Feldmann teaches that such a layer provides greater efficiency than the older point contacts described in Jin) and would not have included an insulating dielectric layer that “would contradict” the entire idea of Feldmann’s TOPCon structure and “lose the inherent advantage” of Feldmann’s approach, and would not have excluded any portion of Feldmann’s “vital” tunnel oxide layer. This is illustrated in this correction to Petitioners’ Proposed Combination:



Such a combination, however, does not render obvious independent claim 1 of the '104 Patent for at least the reason that it does not include either the claimed *“first passivation film on the first conductive type semiconductor region”* or the claimed *“first electrode formed on the first passivation film and connected to the first conductive type semiconductor region through an opening formed in the first passivation film.”*

Further, as shown above, Feldmann illustrates the p^+ -emitter and P-doped Si layers entirely on opposite sides of the cell. As such, there is no risk that they could short-circuit and no need for the claimed *“isolation portion for preventing a contact between the first conductive type semiconductor region and the second conductive type semiconductor region.”*

Petitioners, however, argue Jin’s “gap T between the back surface field layer 150 and the edge of the rear surface of the substrate 110” (Ex. 1009, [0059]) is the claimed isolation portion and would be included in the proposed combination. Even accepting for purposes of this preliminary response that a POSITA would have (i) adopted the portions of Jin’s emitter along the sides of the cell (rather than Feldmann’s structure showing the emitter only on the top surface of the cell) and (ii) then included Jin’s “gap T,” that gap is not the claimed “isolation portion” that “*excludes the tunnel layer.*” And claim 1 of the ’104 Patent further requires “*the first passivation film covers the first surface of the semiconductor substrate and the isolation portion together.*” As explained, in the corrected proposed combination there is no first passivation film but even were a POSITA to ignore Feldmann’s teachings and include such a dielectric layer, there is no suggestion that the POSITA would extend it to cover gap T.

C. The Petition Failed to Establish a Reasonable Likelihood of Success For Ground 2 (Chang and Jin)

Ground 2 – the combination of Chang and Jin – is the only other Ground that purports to invalidate independent claim 1 of the ’104 Patent. Because Petitioners do not meet their burden to prove that this combination renders claim 1 obvious, neither it, nor the Grounds that depend from it, render obvious any challenged claim.

1. Chang (Ex. 1013)

Chang is a U.S. Patent application published October 9, 2014 entitled “solar cell.” Petitioners focus on the embodiments shown in Chang FIGs. 1 and 8:

FIG. 1

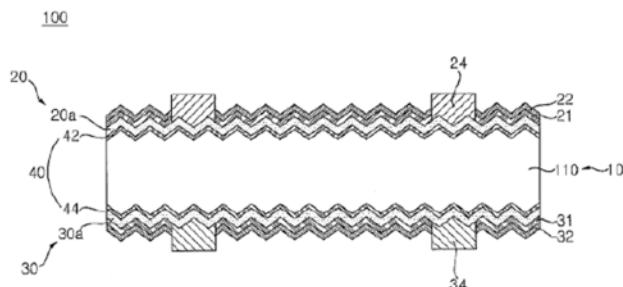
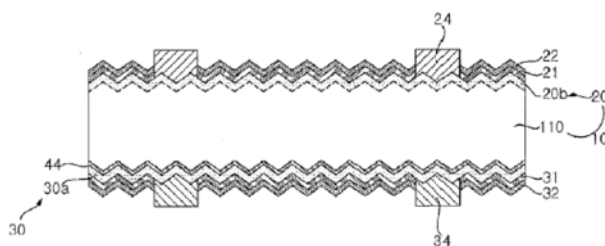


FIG. 8



Petition at 54-57 *citing* Chang, FIGs. 1 and 8.

Petitioners contend that “Chang implemented Feldmann’s TOPCon structure into a bifacial solar cell....” (Petition at 49.) Like Feldmann, Chang’s “conductive type areas **20** and **30**” (Ex. 1013, [0036]) are at opposite sides of the solar cell. Thus, Chang does not need or disclose the ’104 Patent’s “isolation portion.” To the contrary, Chang specifically teaches that “[b]ecause the emitter area **20** and the back surface field area **30** are not adjacent to each other, the necessity of performing an isolation process when the emitter area **20** and the back surface field area **30** are formed to be adjacent to each other is eliminated.” (*Id.* [0076]). Chang recites the advantages of not including an isolation portion. “As a result, manufacturing process is simplified and cost is thus reduced.” (*Id.*).

Chang is cited on the face of the '104 Patent and the Examiner allowed the claims because Chang neither disclosed nor rendered obvious the isolation portion. Chang was specifically addressed during the prosecution of U.S. Patent No. 10,014,419, from which the '104 Patent is a continuation. The '419 Patent claimed “[a] method for manufacturing a solar cell” that included a “removing step” that comprises “forming an isolation portion by removing the tunnel layer on the side of the semiconductor substrate and an edge portion of the first conductive type semiconductor region....” (Ex. 1006 at 264). During prosecution, the Examiner correctly noted that Chang “do[es] not teach or render obvious the claimed features of [i] the removing step as recited and [ii] the first passivation film covering the first surface of the semiconductor substrate along with the isolation portion.” (*Id.* at 254). Like its parent patent, independent claim 1 of the '104 Patent also claims [i] an “*isolation portion*” that excludes the tunnel layer and [ii] that “*the first passivation film covers the first surface of the semiconductor substrate and the isolation portion together.*”

2. Chang and Jin Do Not Render Claim 1 Obvious

Petitioners’ Ground 2 is confusing. *First*, Petitioners argue “[t]he Chang/Jin combination requires no modification to Chang’s device....” (Petition, 52). But, without modification, Chang’s device clearly does not meet the limitations of claim 1. Petitioners admit “Chang’s Figures 1 and 8 [upon which they rely] did not show

an isolation portion” as required by challenged claim 1. (Petition, 50). This is exactly what the Examiner held during prosecution of the parent application. (Ex. 1006 at 254).

Rather than render obvious the claimed isolation portion, Chang FIGs. 1 and 8 illustrate why Chang’s solar cell does not need one:

FIG. 1

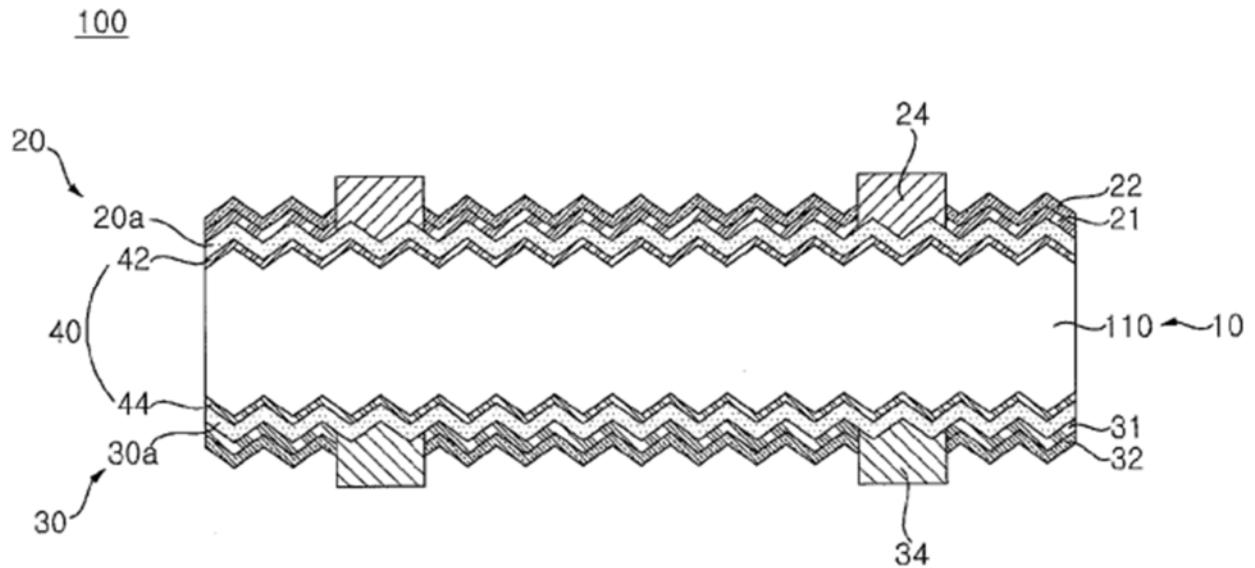
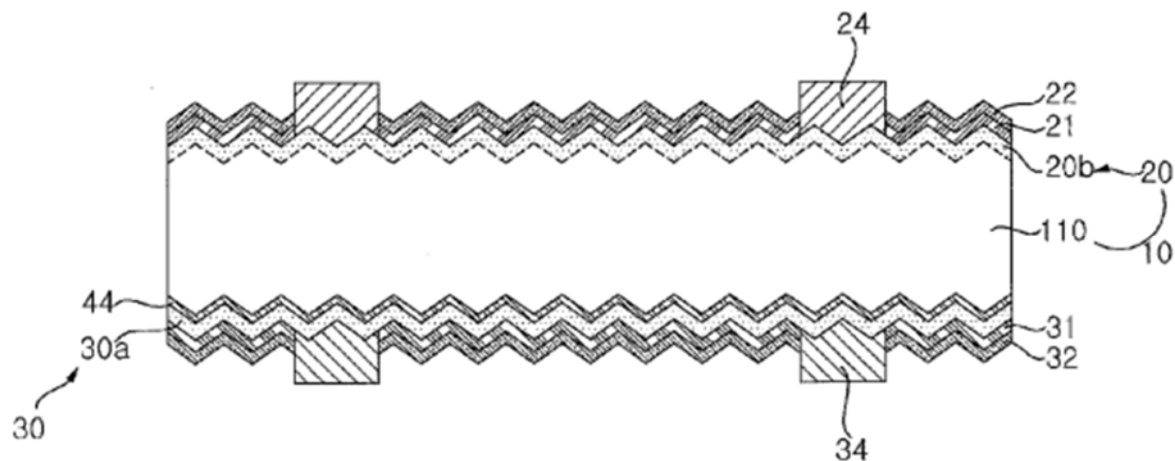


FIG. 8



Both figures show similar solar cells with a conductive “emitter area **20** and a back surface field area **30**....” (Ex. 1013, [0036]). These areas are of opposite conductivity types. “One of the emitter area 20 and the back surface field area 30 is referred to as a ‘first conductive type area’ and the other is referred to as a ‘second conductive type area’.” (*Id.* [0037]). Chang teaches that, as illustrated in the figures, “the emitter area **20** and the back surface field area **30** may be disposed at different sides of the semiconductor substrate **10** to form a double-surface light-receiving type structure.” (*Id.* [0076]). Because these conductive regions are “disposed at different sides” of the substrate, they cannot form a short-circuit and, thus, Chang has no need for an isolation portion, as required by claim 1 of the ’104 Patent ***“for preventing a contact between the first conductive type semiconductor region and the second conductive type semiconductor region.”***

Second, despite admitting that “Chang’s Figures 1 and 8 did not show an isolation portion,” Petitioners contend “the specification describes it.” (Petition, 50). That is not correct. Nowhere in its specification does Chang describe the isolation portion required by claim 1 of the ’104 Patent. To the contrary, Chang’s specification expressly teaches that a benefit of Chang’s conductive regions being “disposed at different sides” of the substrate is that no isolation portion is required. ***“Because the emitter area 20 and the back surface field area 30 are not adjacent*** to each other, the necessity of ***performing an isolation process*** when the emitter area 20 and the

back surface field area 30 are formed to be adjacent to each other *is eliminated.*” (Ex. 1013, [0076]) (emphasis added). “As a result, manufacturing process is simplified and cost is thus reduced.” (*Id.*).

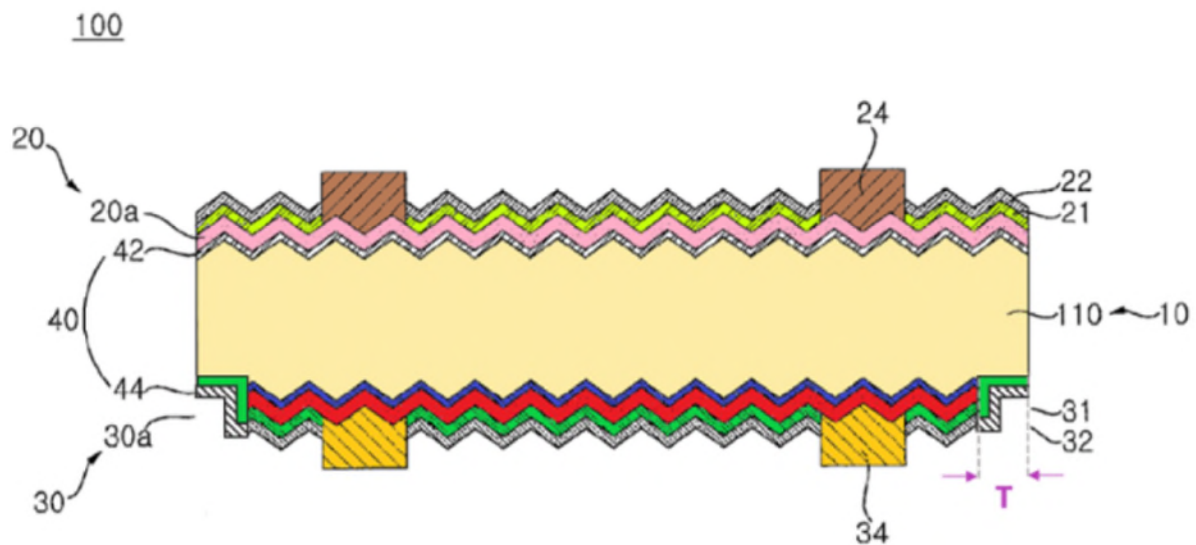
Petitioners and their expert ignore Chang’s express teaching that its structure eliminates the need for an isolation portion. Instead, Petitioners’ entire argument is premised on the fact that while Chang states that (as shown in FIGs 1 and 8) tunneling layer **44** is “entirely formed” over the back surface of substrate **10** (*id.* [0056]) and (as shown in FIGs 1 and 8) back surface field area **30** is “entirely formed” over the second tunneling layer **44** (*id.* [0062]), a POSITA would understand this to disclose the isolation portion Chang teaches “is eliminated.” Petition, 50-51. Petitioners’ argument relies on the fact that in both instances Chang states “[a]s used herein, the expression ‘entirely formed’ means that an element such as a layer is formed over an entire surface without an empty area or a non-coverage area, or is formed in an entire area excluding pre-designated or inevitably formed regions such as periphery region, isolation region or the like.” (*Id.*, [0056], [0062]). Petitioners argue that this reference to an “isolation region” means that Chang teaches the specific isolation portion required by claim 1 of the ’104 Patent.

Not so. Again, Chang specifically describes that one benefit of its structure is that no such isolation portion is required. (*Id.*, [0076]). Fatal to Petitioners’ argument, while Chang’s “entirely formed” language could potentially exclude “pre-

designated or inevitably formed regions,” Chang does not “pre-designate” the isolation portion claimed by the ’104 Patent and such an isolation portion is not “inevitably formed.” Indeed, Petitioners admit that both Feldmann and Chang’s FIGs. 1 and 8 do not show such an isolation portion.

Third, while Petitioners claim “[t]he Chang/Jin combination requires no modifications to Chang’s device,” Petitioners proceed to describe and rely upon modifications to Chang a POSITA would supposedly make based on Jin:

Combination of Chang and Jin

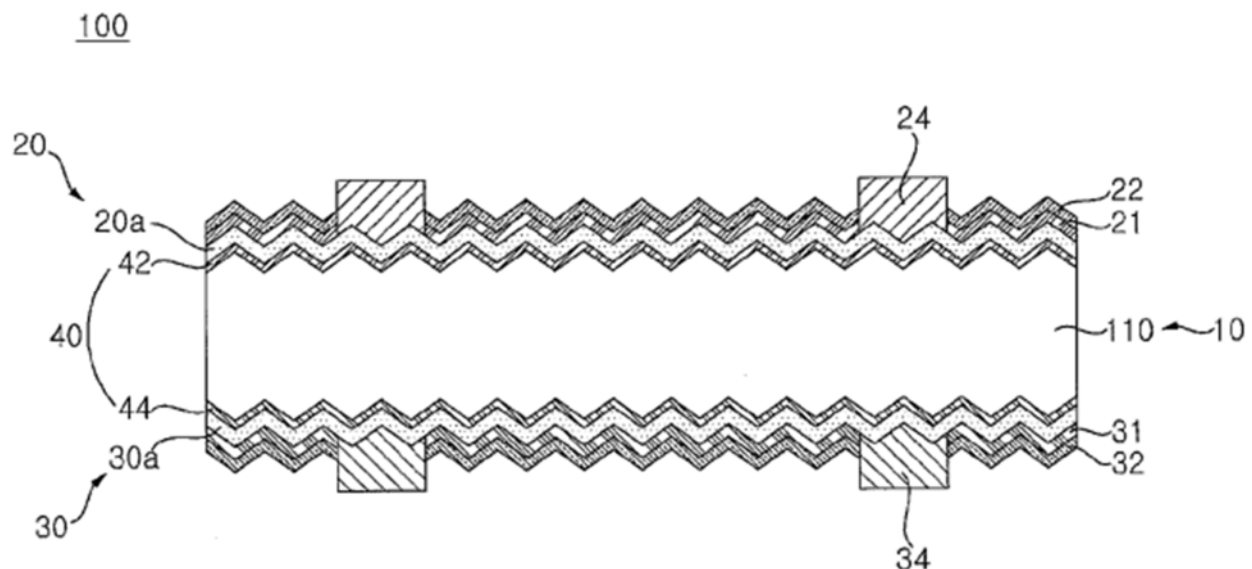


(Petition, 51). Petitioners’ proposed combination purports to add “isolation portions” to the lower left and right corners of Chang FIG. 1.

Petitioners purport to add these indented “isolation portions” “because others taught and understood that the isolation region was an important tool for preventing the emitter and BSF from being shorted.” (Petition, 52). This is perplexing because

the “isolation regions” and gap “T” with which Petitioners seek to add to modify Chang have nothing to do with preventing emitter (20) from being shorted with BSF (30). As shown in Chang’s original FIG. 1, those regions are on separate sides of the cell and would not short even without and an additional isolation portion:

FIG. 1



Given that Chang specifically teaches (i) that its emitter and BSF regions are “not adjacent to each other” (and, thus, cannot short), (ii) the need for “performing an isolation process is eliminated,” and (iii) not performing an (unnecessary) isolation process results in a “simplified” manufacturing process and “reduced” cost, (Ex. 1013, [0076]), there is no motivation for a POSITA to modify Chang and add an unnecessary, complicated, and expensive isolation step. That is why the Examiner allowed the claims over Chang – Chang “do[es] not teach or render

obvious the claimed features of... the first passivation film covering the first surface of the semiconductor substrate along with the isolation portion.” (Ex. 1006, 254).

Even if a POSITA were motivated to ignore Chang’s teachings and introduce an unnecessary isolation process to add Jin’s gap T, Petitioners provide no explanation or support for their argument that in this hypothetical combination a POSITA would exclude Chang’s tunnel layer from the isolation portion. Chang teaches that its “tunnelling layer is formed on the semiconductor substrate” and, as noted above, during the prosecution of the patent’s parent application the Office specifically considered Chang and properly concluded that it did not teach or disclose forming an isolation region where the tunnel layer was removed (and thus excluded). (Ex. 1006 at 254).

Thus, Petitioners have not met their burden to prove a reasonable likelihood that the combination of Chang and Jin render obvious claim 1 of the ’104 Patent. There is no motivation for a POSITA to make that combination, Chang specifically criticized it, and, at a minimum, the combination does not disclose (i) “*an isolation portion for preventing a contact between the first conductive type semiconductor region and the second conductive type semiconductor region*” (ii) “*wherein the isolation portion excludes the tunnel layer and the first conductive type semiconductor region, and is in an edge portion of the first surface of the*

semiconductor substrate, and” (iii) “the first passivation film covers the first surface of the semiconductor substrate and the isolation portion together.”

III. CONCLUSION

For the above reasons, Patent Owner respectfully requests that the Board deny institution of *inter partes* review of the ’104 Patent.

Dated: March 12, 2025

Respectfully submitted,

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CERTIFICATE OF WORD COUNT

The undersigned certifies that the foregoing paper complies with the type-volume limitation in 37 C.F.R. § 42.24. According to the utilized word-processing system's word count, the paper—excluding any portions mentioned in § 42.24(a)(1)—contains 5,924 words.

Dated: March 12, 2025

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CERTIFICATION OF SERVICE (37 C.F.R. § 42.6(e))

The undersigned certifies that on March 12, 2025, a copy of the following was served in its entirety via electronic mail, upon the following attorneys of record for the Petitioners:

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/Karen Johnson/

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