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Application Number	
Filing Date	02-Jul-2019
First Named Inventor	Peter John COUSINS
Title	FRONT CONTACT SOLAR CELL WITH FORMED EMITTER
Art Unit	
Examiner Name	
Attorney Docket Number	10031.004212

SIGNATURE of Applicant or Patent Practitioner

Signature	/Patrick D. Benedicto/	Date (Optional)	
Name	PATRICK D. BENEDICTO	Registration Number	40,909
Title (if Applicant is a juristic entity)	Attorney of Record		
Applicant Name (if Applicant is a juristic entity)		SunPower Corporation	

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This collection of information is required by 37 CFR 1.131, 1.32, and 1.33. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 3 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

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I hereby revoke all previous powers of attorney given in the application identified in either the attached transmittal letter or the boxes below.

Application Number	Filing Date

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☒ I hereby appoint the Patent Practitioner(s) associated with the following Customer Number as my/our attorney(s) or agent(s), and to transact all business in the United States Patent and Trademark Office connected therewith for the application referenced in the attached transmittal letter (form PTO/AIA/82A) or identified above:

74254

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☐ I hereby appoint Practitioner(s) named in the attached list (form PTO/AIA/82C) as my/our attorney(s) or agent(s), and to transact all business in the United States Patent and Trademark Office connected therewith for the patent application referenced in the attached transmittal letter (form PTO/AIA/82A) or identified above. (Note: Complete form PTO/AIA/82C.)

Please recognize or change the correspondence address for the application identified in the attached transmittal letter or the boxes above to:

☒ The address associated with the above-mentioned Customer Number

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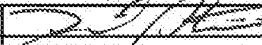
I am the Applicant (if the Applicant is a juristic entity, list the Applicant name in the box):

SUNPOWER CORPORATION

- ☐ Inventor or Joint Inventor (title not required below)
- ☐ Legal Representative of a Deceased or Legally Incapacitated Inventor (title not required below)
- ☒ Assignee or Person to Whom the Inventor is Under an Obligation to Assign (provide signer's title if applicant is a juristic entity)
- ☐ Person Who Otherwise Shows Sufficient Proprietary Interest (e.g., a petition under 37 CFR 1.46(b)(2) was granted in the application or is concurrently being filed with this document) (provide signer's title if applicant is a juristic entity)

SIGNATURE of Applicant for Patent

The undersigned (whose title is supplied below) is authorized to act on behalf of the applicant (e.g., where the applicant is a juristic entity).

Signature		Date (Optional)	March 14, 2014
Name	DAVID PETRINI		
Title	HEAD IP COUNSEL, SUNPOWER CORPORATION		

NOTE: Signature - This form must be signed by the applicant in accordance with 37 CFR 1.33. See 37 CFR 1.4 for signature requirements and certifications. If more than one applicant, use multiple forms.

☒ Total of 1 forms are submitted.

This collection of information is required by 37 CFR 1.131, 1.32, and 1.33. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 3 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.

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FRONT CONTACT SOLAR CELL WITH FORMED EMITTER

Inventor: Peter John Cousins

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REFERENCE TO RELATED APPLICATIONS

This application is a continuation of U.S. Application No. 14/504,771, filed on October 2, 2014, which is a continuation of U.S. Application No. 13/495,577, filed on June 13, 2012, now U.S. Patent No. 8,878,053, which is a divisional of U.S. Application
10 No. 12/070,742, filed on February 20, 2008, now U.S. Patent No. 8,222,516. The just-mentioned disclosures are incorporated herein by reference in their entirety.

BACKGROUND OF THE INVENTION

1. Field of the Invention

15 The present invention relates generally to solar cells, and more particularly but not exclusively to solar cell fabrication processes and structures.

2. Description of the Background Art

Solar cells are well known devices for converting solar radiation to electrical energy. They may be fabricated on a semiconductor wafer using semiconductor
20 processing technology. A solar cell includes P-type and N-type diffusion regions that form a junction. Solar radiation impinging on the solar cell creates electrons and holes that migrate to the diffusion regions, thereby creating voltage differentials between the diffusion regions. In a backside contact solar cell, both the diffusion regions and the

metal contacts coupled to them are on the backside of the solar cell. The metal contacts allow an external electrical circuit to be coupled to and be powered by the solar cell.

5 In a front contact solar cell, at least one of the metal contacts making an electrical connection to a diffusion region is on the front side of the solar cell. The front side of the solar cell, which is opposite the backside, faces the sun during normal operation to collect solar radiation. While backside contact solar cells have an aesthetic advantage over front contact solar cells due to the absence of metal contacts on the front side, and are thus preferred for residential applications, aesthetics is not a major
10 requirement for power plants and other applications where power generation is the main concern. Disclosed herein are structures for a relatively efficient and cost-effective front contact solar cell and processes for manufacturing same.

SUMMARY

15 A bipolar solar cell includes a backside junction formed by an N-type silicon substrate and a P-type polysilicon emitter formed on the backside of the solar cell. An antireflection layer may be formed on a textured front surface of the silicon substrate. A negative polarity metal contact on the front side of the solar cell makes an electrical connection to the substrate, while a positive polarity metal contact on the backside of
20 the solar cell makes an electrical connection to the polysilicon emitter. An external electrical circuit may be connected to the negative and positive metal contacts to be powered by the solar cell. The positive polarity metal contact may form an infrared reflecting layer with an underlying dielectric layer for increased solar radiation collection.

These and other features of the present invention will be readily apparent to persons of ordinary skill in the art upon reading the entirety of this disclosure, which includes the accompanying drawings and claims.

5 DESCRIPTION OF THE DRAWINGS

FIG. 1 schematically shows a cross-section of a solar cell in accordance with an embodiment of the present invention.

FIG. 2 is a plan view schematically showing the front side of the solar cell of FIG. 1.

10 FIG. 3 is a plan view schematically showing the backside of the solar cell of FIG. 1.

FIG. 4, which comprises FIGS. 4A-4M, schematically illustrates the fabrication of the solar cell of FIG. 1 in accordance with an embodiment of the present invention.

The use of the same reference label in different figures indicates the same or like
15 components. The figures are not drawn to scale.

DETAILED DESCRIPTION

In the present disclosure, numerous specific details are provided, such as examples of apparatus, process parameters, materials, process steps, and structures,
20 to provide a thorough understanding of embodiments of the invention. Persons of ordinary skill in the art will recognize, however, that the invention can be practiced

without one or more of the specific details. In other instances, well-known details are not shown or described to avoid obscuring aspects of the invention.

FIG. 1 schematically shows a cross-section of a solar cell 100 in accordance with an embodiment of the present invention. The solar cell 100 has a front side where a metal contact 102 is located and a backside on a same side as the metal contact 110. The front side faces the sun during normal operation to collect solar radiation.

In the example of FIG. 1, the solar cell 100 includes a backside junction formed by a P-type doped polysilicon emitter 108 serving as a P-type diffusion region and an N-type silicon substrate 101 serving as an N-type diffusion region. The N-type silicon substrate 101 may comprise a long lifetime (e.g., 2 to 5ms) N-type silicon wafer and may have a thickness of about 100 to 250 μm as measured from the backside surface to a tip of the textured front side surface of the substrate. The front side surface of the substrate 101 is randomly textured (labeled as 113) and includes N-type doped regions 105 and 106 formed in the substrate. The N-type doped region 105 provides low front surface recombination and improves lateral conductivity whilst not compromising the blue response of the solar cell. The region 106, which may be a phosphorus diffusion, provides low contact resistance and minimizes contact recombination. The region 106 is also referred to as an "N-dot" because, in one embodiment, it forms a dot-shape to minimize the area of heavily diffused regions on the front surface. The N-type doped region 105 may have a sheet resistance of 100 to 500 Ω/sq , whilst the n-type doped region 106 may have a sheet resistance of 10 to 50 Ω/sq .

An antireflective coating (ARC) of silicon nitride layer 103 is formed on the textured front side surface of the substrate 101. The texture front side surface and the

silicon nitride layer 103 help improve solar radiation collection efficiency. A passivating oxide 124 may comprise silicon dioxide thermally grown to a thickness of about 10 to 250 Angstroms on the front side surface of the substrate 101.

In one embodiment, the polysilicon emitter 108 is formed on a tunnel oxide layer 107. The polysilicon emitter 108 may be formed by forming a layer of polysilicon using Chemical Vapor Deposition (CVD), such as Low Pressure CVD (LPCVD) or Plasma Enhanced CVD (PECVD), and thermal anneal. The polysilicon emitter 108 may have a sheet resistance of 100 Ω /sq, and a thickness of 1000 to 2000 Angstroms. The tunnel oxide layer 107 may comprise silicon dioxide thermally grown to a thickness of about 10 to 50 Angstroms on the backside surface of the substrate 101. A metal contact 110 electrically connects to the polysilicon emitter 108 through contact holes 123 formed through a dielectric comprising a silicon dioxide layer 109. The metal contact 110 provides a positive polarity terminal to allow an external electrical circuit to be coupled to and be powered by the solar cell 100. The silicon dioxide layer 109 provides electrical isolation and allows the metal contact 110 to serve as an infrared reflecting layer for increased solar radiation collection. In one embodiment, the metal contact 110 comprises silver having a conductance of about 5-25 m Ω .cm and a thickness of about 15-35 μ m.

On the front side of the solar cell 100, the metal contact 102 electrically connects to the region 106 through a contact hole 120 formed through the silicon nitride layer 103. The metal contact 102 provides a negative polarity terminal to allow an external electrical circuit to be coupled to and be powered by the solar cell 100. In one embodiment, the metal contact 102 comprises silver having a sheet resistance of about

5m Ω .cm and a thickness of about 15 μ m. The pitch between adjacent metal contacts 102 may be about 1 to 4 mm. In one embodiment, the metal contacts 102 are spaced at 400 to 1000 μ m along each metal contact 102 (see FIG. 2).

In the example of FIG. 1, the edge isolation trench 111 is formed through the silicon dioxide layer 109, the polysilicon emitter 108, and a portion of the substrate 101 to provide edge electrical isolation.

FIG. 2 is a plan view schematically showing the front side of the solar cell 100. In the example of FIG. 2, two bus bars 201 run parallel on the front side of the substrate 101. The contact holes 120, in which the metal contacts 102 are formed, may each have a diameter of about 50 to 200 μ m. A plurality of metal contacts 102 is formed perpendicular to the bus bars 201. Each metal contact 102 may have a width of about 60-120 μ m.

FIG. 3 is a plan view schematically showing the backside of the solar cell 100. In the example of FIG. 3, two bus bars 301, which are electrically coupled to metal contacts 110, run parallel on the backside. In practice, the bus bars 201 and 301 will be electrically connected to corresponding bus bars of adjacent solar cells to form an array of solar cells.

Solar cells have gained wide acceptance among energy consumers as a viable renewable energy source. Still, to be competitive with other energy sources, a solar cell manufacturer must be able to fabricate an efficient solar cell at relatively low cost. With this goal in mind, a process for manufacturing the solar cell 100 is now discussed with reference to FIGS. 4A-4M.

FIG. 4, which comprises FIGS. 4A-4M, schematically illustrates the fabrication of the solar cell 100 in accordance with an embodiment of the present invention.

In FIG. 4A, an N-type silicon substrate 101 is prepared for processing into a solar cell by undergoing a damage etch step. The substrate 101 is in wafer form in this example, and is thus typically received with damaged surfaces due to the sawing process used by the wafer vendor to slice the substrate 101 from its ingot. The substrate 101 may be about 100 to 200 microns thick as received from the wafer vendor. In one embodiment, the damage etch step involves removal of about 10 to 20 μm from each side of the substrate 101 using a wet etch process comprising potassium hydroxide. The damage etch step may also include cleaning of the substrate 101 to remove metal contamination.

In FIG. 4B, tunnel oxides 402 and 107 are formed on the front and back surfaces, respectively, of the substrate 101. The tunnel oxides 402 and 107 may comprise silicon dioxide thermally grown to a thickness of about 10 to 50 Angstroms on the surfaces of the N-type silicon substrate 101. A layer of polysilicon is then formed on the tunnel oxides 402 and 107 to form the polysilicon layer 401 and the polysilicon emitter 108, respectively. Each of the polysilicon layer 401 and the polysilicon emitter 108 may be formed to a thickness of about 1000 to 2000 Angstroms by CVD.

In FIG. 4C, a P-type dopant source 461 is formed on the polysilicon emitter 108. As its name implies, the P-type dopant source 461 provides a source of P-type dopants for diffusion into the polysilicon emitter 108 in a subsequent dopant drive-in step. A dielectric capping layer 462 is formed on the P-type dopant source 461 to prevent dopants from escaping from the backside of the solar cell during the drive-in step. In

one embodiment, the P-type dopant source comprises BSG (borosilicate glass) deposited to a thickness of about 500 to 1000 Angstroms by atmospheric pressure CVD (APCVD) and has a dopant concentration of 5 to 10% by weight, while the capping layer 462 comprises undoped silicon dioxide formed to a thickness of about 2000 to 3000
5 Angstroms also by APCVD.

In FIG. 4D, the edge isolation trench 111 is formed near the edge of the substrate 101 on the backside. The trench 111 is relatively shallow (e.g., 10 μm deep into the substrate 101) and provides edge electrical isolation. In one embodiment, the trench 111 is formed by cutting through the capping layer 462, the P-type dopant source
10 461, the polysilicon emitter 108, the tunnel oxide 107, and into a shallow portion of the substrate 101 using a laser.

In FIG. 4E, exposed regions on the front surface of the substrate 101 is randomly textured to form the textured surface 113. In one embodiment, the front surface of the substrate 101 is textured with random pyramids using a wet etch process comprising
15 potassium hydroxide and isopropyl alcohol.

In FIG. 4F, an N-type dopant source 412 is formed on regions of the textured surface 113 where contact holes 120 (see FIG. 1) will be subsequently formed to allow subsequently formed metal contacts 102 to electrically connect to the substrate 101. As its name implies, the N-type dopant source 412 provides a source of N-type dopants for
20 diffusion into the front side of the substrate 101. In one embodiment, the N-type dopant source 412 is formed by inkjet printing the dopant material directly onto the substrate 101.

In one embodiment, the N-type dopant source 412 comprises silicon dioxide doped with phosphorus. Only one N-type dopant source 412 is shown in FIG. 4F for clarity of illustration. In practice, there are several dot-shaped N-type dopant sources 412, one for each region where a contact hole 120 is to be formed (see FIG. 2). This
5 allows formation of several dot shaped N-type doped regions 106 (see FIG. 1) after a subsequently performed drive-in step now discussed with reference to FIG. 4G.

In FIG. 4G, a dopant drive-in step is performed to diffuse N-type dopants from the N-type dopant source 412 into the substrate 101 to form the N-type dope region 106, to diffuse P-type dopants from the P-type dopant source 461 to the polysilicon
10 emitter 108, and to diffuse N-type dopants into the front side of the substrate 101 to form the N-type doped region 105. Silicon dioxide layer 109 represents layers 461 and 462 after the drive-in step. The polysilicon emitter 108 also becomes a P-type doped layer after the drive-in step. The N-type doped region 105 may be formed by exposing the sample of FIG. 4G to phosphorus in a diffusion furnace, for example. The use of the
15 N-type dopant source 412 allows for a more controlled and concentrated N-type diffusion to the N-type doped region 106. The thin thermal silicon dioxide layer 124 may be grown on the textured surface 113 during the drive-in process.

The drive-in step to dope the polysilicon emitter 108 on the backside and to form the N-type doped regions 105 and 106 on the front side may be formed in-situ, which in
20 the context of the present disclosure 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. In one embodiment, the drive-in step is performed in a

diffusion furnace. The preceding sequence of steps leading to the drive-in step allows for in-situ diffusion, which advantageously helps in lowering fabrication cost.

It is to be noted that the step of using an N-type dopant source 412 to diffuse dopants into the N-type doped region 106 may be omitted in some applications. That is, 5 in an alternative process, the formation of the N-type dopant source 412 in FIG. 4F may be omitted. In that case, the N-type doped regions 105 and 106 will be both doped by introduction of an N-type dopant in the diffusion furnace during the drive-in step. All other process steps disclosed herein remain essentially the same.

In FIG. 4H, the antireflective coating of silicon nitride layer 103 is formed over the 10 textured surface 113 after removal of the N-type dopant source 412. Besides being an antireflective coating, the silicon nitride layer 103 also advantageously serves as a dielectric, enabling the selective contacts to be formed on the front surface to reduce front surface recombination. The silicon nitride layer 103 may be formed to a thickness of about 450 Angstroms by PECVD, for example.

15 In FIG. 4I, a front contact mask 420 is formed on the silicon nitride layer 103 to create a pattern 421 defining the contact holes 120 (see FIG. 1). The mask 420 may comprise an acid resistance organic material, such as a resist, and formed using a printing process, such as screen printing or inkjet printing.

20 In FIG. 4J, a back contact mask 422 is formed on the silicon dioxide layer 109 to create patterns 423 defining the contact holes 123 (see FIG. 1). Similar to the mask 420, the mask 422 may comprise an organic material formed using a printing process.

In FIG. 4K, contact holes 120 and 123 are formed by removing exposed portions of the silicon nitride layer 103 and the silicon dioxide 109 in a contact etch step. In one embodiment, the contact holes 120 are formed by using a selective etch process that removes exposed portions of the silicon nitride layer 103 and stops on the substrate
5 101. The same etch process removes exposed portions of the silicon dioxide 109 and stops on the polysilicon emitter 108. In one embodiment, the etch process comprises a BOE (buffered oxide etch).

In FIG. 4L, the metal contact 110 is formed on the silicon dioxide layer 109 to fill the contact holes 123 and make electrical connection to the polysilicon emitter 108.
10 The metal contact 110 may be formed using a printing process. The metal contact 110 may comprise silver, which, together with the silicon dioxide layer 109, makes an excellent backside infrared reflector. Other metals may also be used as a metal contact 110, such as aluminum, for example.

In FIG. 4M, the metal contact 120 is formed on the silicon nitride layer 103 to fill
15 the contact holes 120 and make electrical connection to the substrate 101. The metal contact 120 may comprise silver and formed using a printing process.

Formation of the metal contacts 110 and 102 may be followed by a firing step. The firing step is applicable when using screen printed silver paste as metal contacts, but not when using other processes or metals. The solar cell 100 may then be visually
20 inspected and tested.

While specific embodiments of the present invention have been provided, it is to be understood that these embodiments are for illustration purposes and not limiting. Many additional embodiments will be apparent to persons of ordinary skill in the art

Attorney Docket No. 10031.004212

reading this disclosure.

CLAIMS

What is claimed is:

1. A solar cell, comprising:
a substrate;
5 a first tunnel dielectric disposed over the substrate;
an emitter disposed over the first tunnel dielectric;
a front electrode disposed over a front surface of the substrate; and
a back electrode disposed over a back surface of the substrate.
- 10 2. The solar cell of claim 1, wherein the emitter is a polysilicon emitter.
3. The solar cell of claim 1, wherein the substrate is a monocrystalline silicon substrate.
- 15 4. The solar cell of claim 1, wherein the first tunnel dielectric is a tunnel oxide.
5. The solar cell of claim 1, wherein the emitter is disposed over the back surface of the substrate.
- 20 6. The solar cell of claim 1, further comprising a second tunnel dielectric disposed on an opposite side of the substrate than the first tunnel dielectric.
7. The solar cell of claim 1, wherein the back electrode includes silver.
- 25 8. The solar cell of claim 1, further comprising an antireflective layer disposed over the front surface of the substrate.
9. A solar cell, comprising:
a substrate;
30 an emitter over a back surface of the substrate;

a first dielectric between the emitter and back surface;
a front electrode disposed on a front surface of the solar cell; and
a back electrode disposed on a back surface of the solar cell.

5 10. The solar cell of claim 9, wherein the emitter is a polysilicon emitter.

11. The solar cell of claim 9, wherein the substrate is a monocrystalline silicon substrate.

10 12. The solar cell of claim 9, wherein the first dielectric is an oxide.

13. The solar cell of claim 9, further comprising a second dielectric disposed on an opposite side of the substrate than the first dielectric.

15 14. The solar cell of claim 9, wherein the back electrode includes silver.

15. A method of fabricating a solar cell, the method comprising:
forming a first tunnel dielectric on a front surface of a substrate;
forming a second tunnel dielectric on a back surface of the substrate;
20 forming an emitter over the first or second tunnel dielectric;
forming a front side electrode on a front surface of the solar cell; and
forming a back side electrode on a back surface of the solar cell.

16. The method of claim 15, wherein said forming the emitter comprises forming a
25 polysilicon emitter.

17. The method of claim 15, wherein said forming the emitter comprises forming a first silicon layer on the second tunnel dielectric.

30 18. The method of claim 17, further comprising forming a second silicon layer on the first tunnel dielectric.

19. The method of claim 18, wherein forming the first and second silicon layers comprises forming first and second polysilicon layers, respectively.
- 5 20. The method of claim 15, wherein said forming the second tunnel dielectric comprises forming an oxide.

ABSTRACT

A bipolar solar cell includes a backside junction formed by an N-type silicon substrate and a P-type polysilicon emitter formed on the backside of the solar cell. An antireflection layer may be formed on a textured front surface of the silicon substrate. A
5 negative polarity metal contact on the front side of the solar cell makes an electrical connection to the substrate, while a positive polarity metal contact on the backside of the solar cell makes an electrical connection to the polysilicon emitter. An external electrical circuit may be connected to the negative and positive metal contacts to be powered by the solar cell. The positive polarity metal contact may form an infrared
10 reflecting layer with an underlying dielectric layer for increased solar radiation collection.

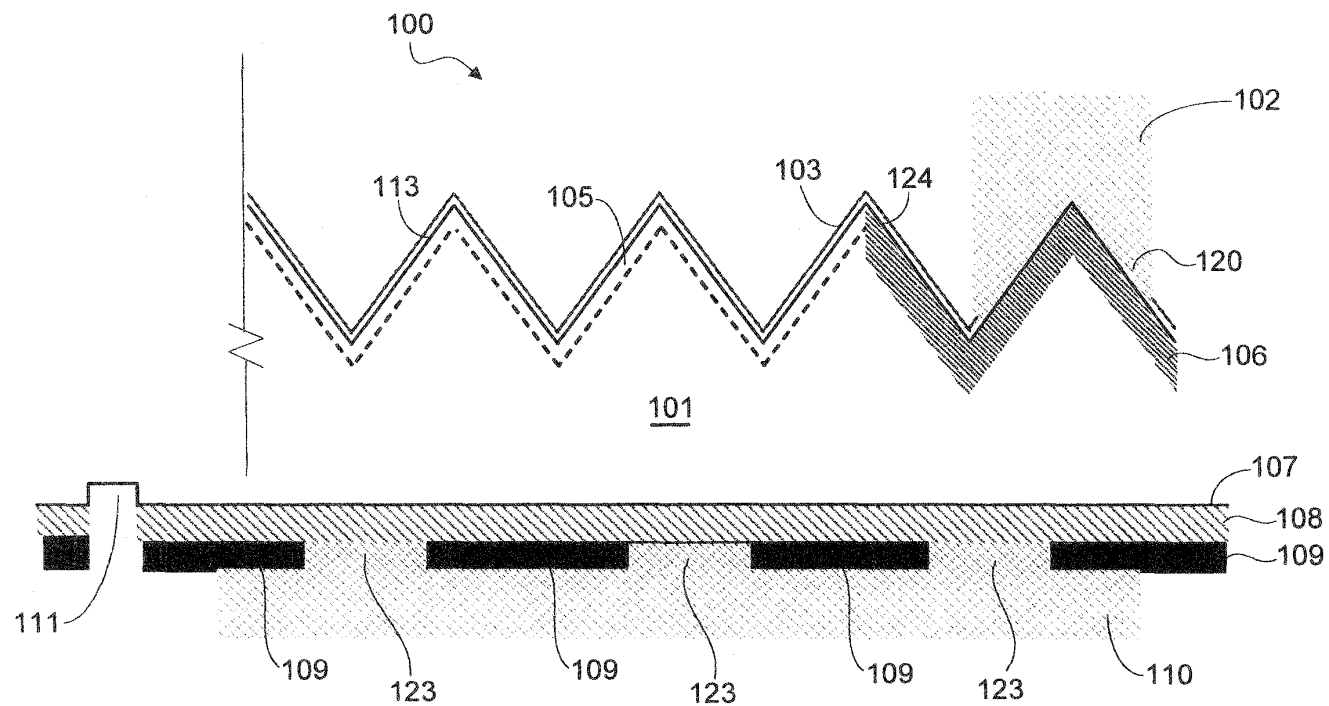


FIG. 1

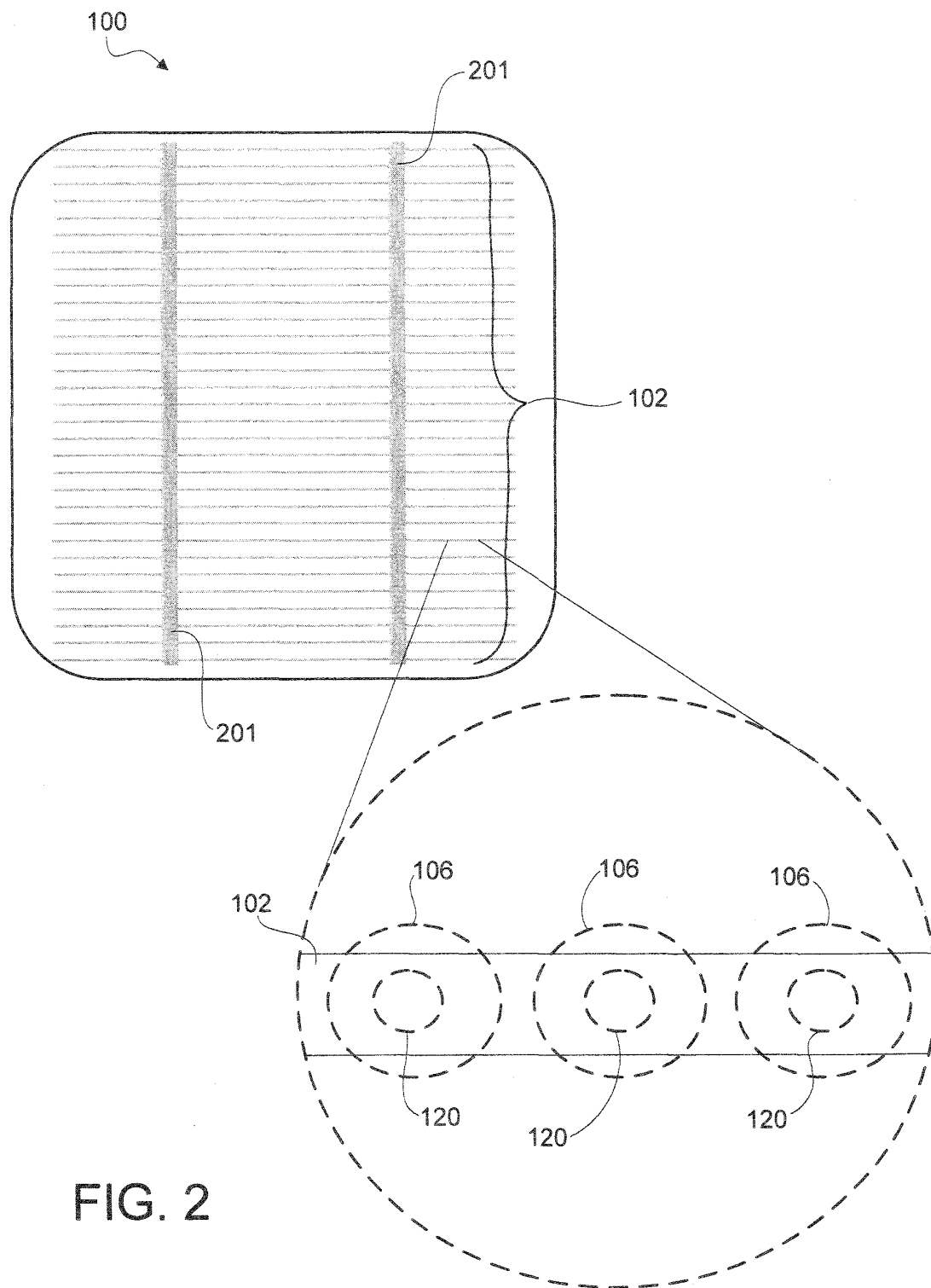


FIG. 2

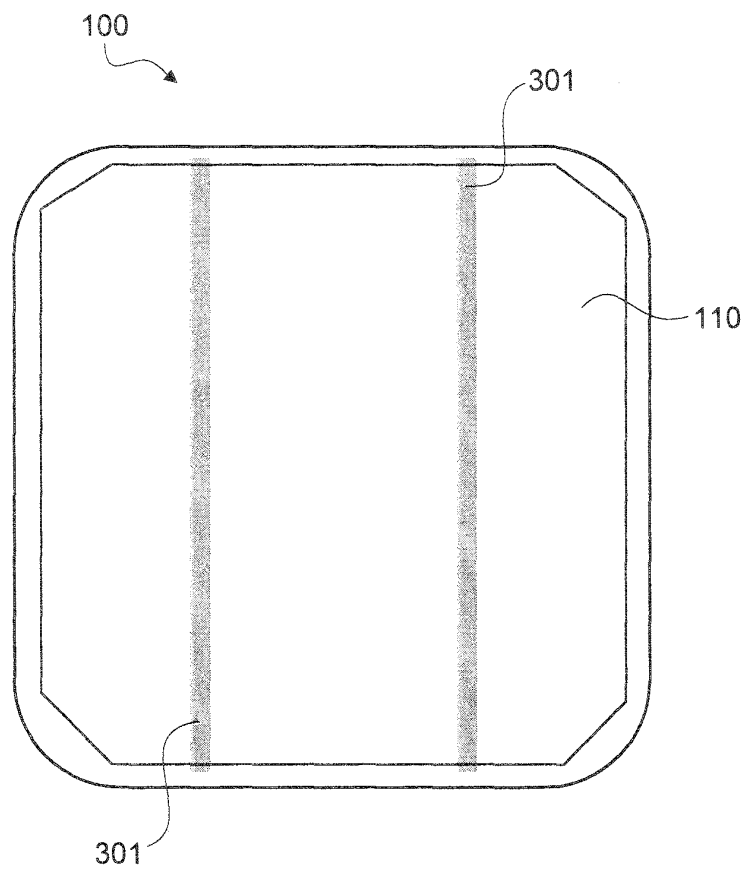


FIG. 3

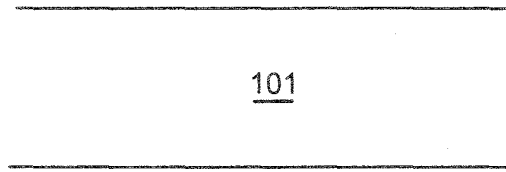


FIG. 4A

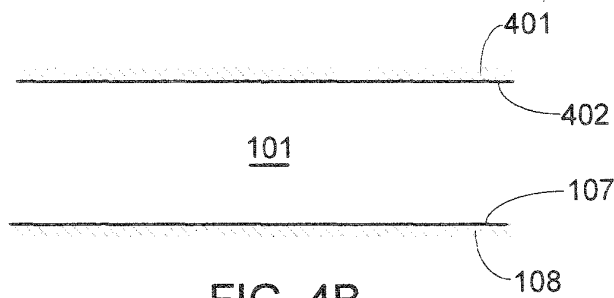


FIG. 4B

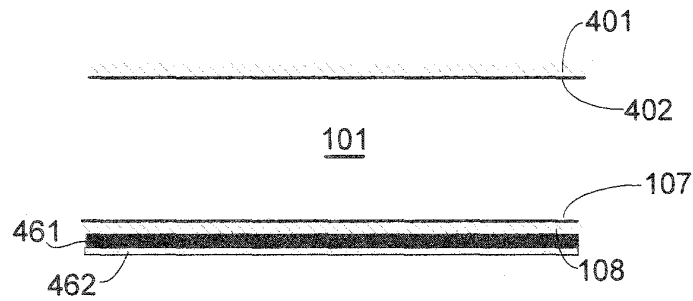


FIG. 4C

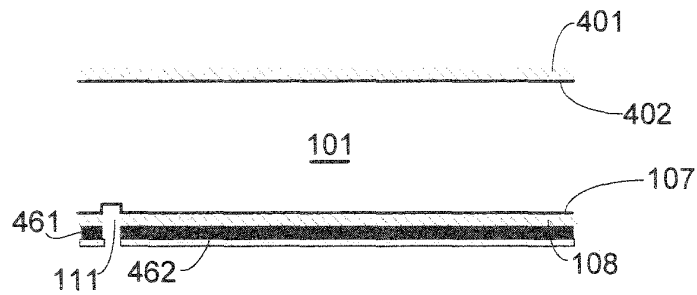


FIG. 4D



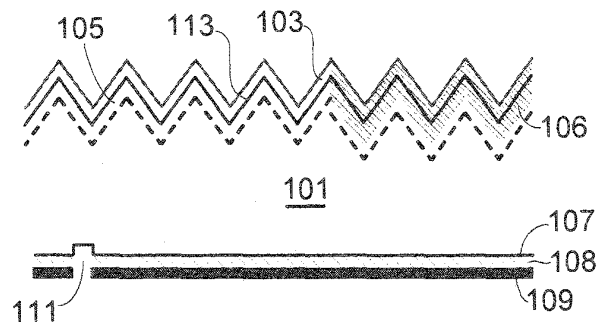


FIG. 4H

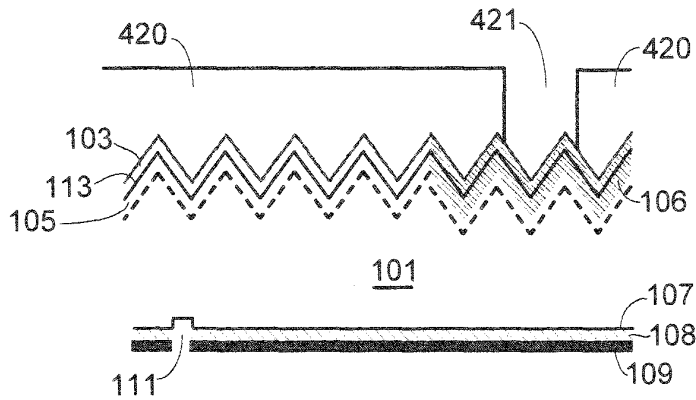


FIG. 4I

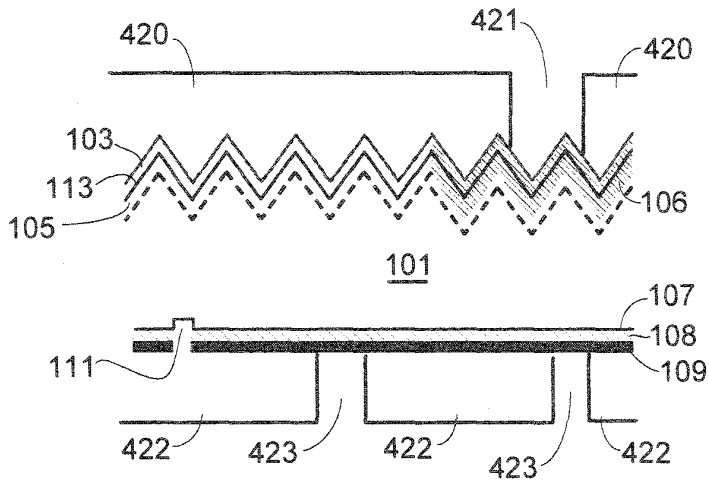


FIG. 4J

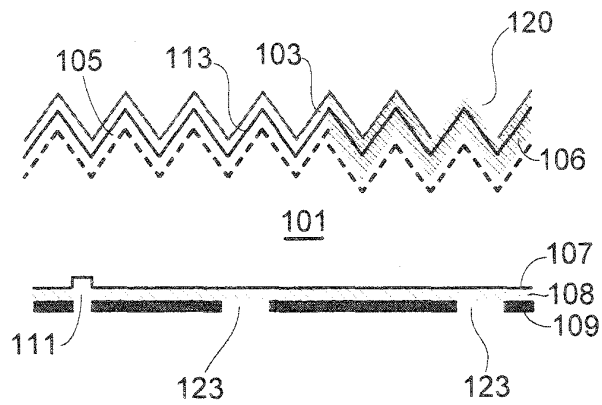


FIG. 4K

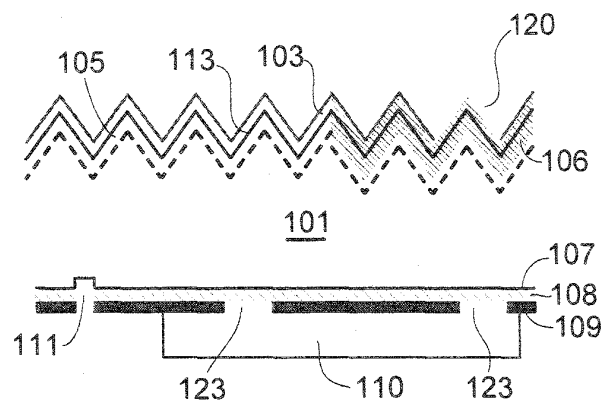


FIG. 4L

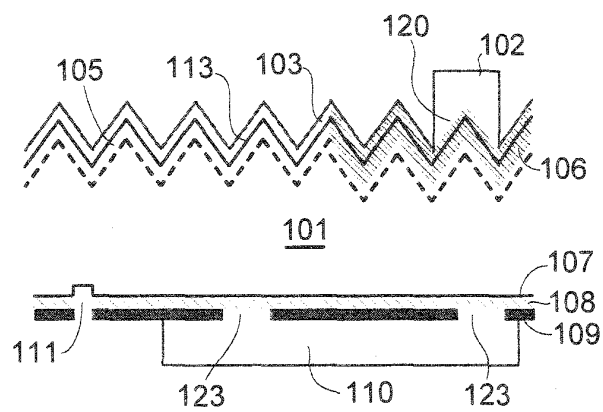


FIG. 4M

Electronic Patent Application Fee Transmittal				
Application Number:				
Filing Date:				
Title of Invention:		FRONT CONTACT SOLAR CELL WITH FORMED EMITTER		
First Named Inventor/Applicant Name:		Peter John COUSINS		
Filer:		Patrick D. Benedicto/Jina Mangaoang		
Attorney Docket Number:		10031.004212		
Filed as Large Entity				
Filing Fees for Utility under 35 USC 111(a)				
Description	Fee Code	Quantity	Amount	Sub-Total in USD(\$)
Basic Filing:				
UTILITY APPLICATION FILING	1011	1	300	300
UTILITY SEARCH FEE	1111	1	660	660
UTILITY EXAMINATION FEE	1311	1	760	760
Pages:				
Claims:				
Miscellaneous-Filing:				
LATE FILING FEE FOR OATH OR DECLARATION	1051	1	160	160
Petition:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD(\$)
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
Extension-of-Time:				
Miscellaneous:				
Total in USD (\$)				1880

Electronic Acknowledgement Receipt	
EFS ID:	36474505
Application Number:	16460035
International Application Number:	
Confirmation Number:	5633
Title of Invention:	FRONT CONTACT SOLAR CELL WITH FORMED EMITTER
First Named Inventor/Applicant Name:	Peter John COUSINS
Customer Number:	74254
Filer:	Patrick D. Benedicto/Jina Mangaoang
Filer Authorized By:	Patrick D. Benedicto
Attorney Docket Number:	10031.004212
Receipt Date:	02-JUL-2019
Filing Date:	
Time Stamp:	13:34:09
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment		no			
File Listing:					
Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Application Data Sheet	S0123US3_AD5aia0014.pdf	1256147	no	8
			6eccb61634ca65ec8b243b92352db85bc0b06636		
Warnings:					

Information:					
2	Power of Attorney	PowerOfAttorney.pdf	674498	no	2
			916300f412873fc5a84d481f3219af76d31a97a7		
Warnings:					
Information:					
3		S0123US3_CONT.pdf	2004718	yes	23
			69545d4f5d14569e9a20128a6f4792c05e80e72e		
	Multipart Description/PDF files in .zip description				
	Document Description		Start	End	
	Specification		1	12	
	Claims		13	15	
	Abstract		16	16	
	Drawings-only black and white line drawings		17	23	
Warnings:					
Information:					
4	Fee Worksheet (SB06)	fee-info.pdf	36589	no	2
			4af98e6849e9aef219bd6a0c480839be1b3b4581		
Warnings:					
Information:					
Total Files Size (in bytes):			3971952		

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number.

Application Data Sheet 37 CFR 1.76		Attorney Docket Number	10031.004212
		Application Number	
Title of Invention	FRONT CONTACT SOLAR CELL WITH FORMED EMITTER		
The application data sheet is part of the provisional or nonprovisional application for which it is being submitted. The following form contains the bibliographic data arranged in a format specified by the United States Patent and Trademark Office as outlined in 37 CFR 1.76. This document may be completed electronically and submitted to the Office in electronic format using the Electronic Filing System (EFS) or the document may be printed and included in a paper filed application.			

Secrecy Order 37 CFR 5.2:

☐	Portions or all of the application associated with this Application Data Sheet may fall under a Secrecy Order pursuant to 37 CFR 5.2 (Paper filers only. Applications that fall under Secrecy Order may not be filed electronically.)
--------------------------	---

Inventor Information:

Inventor	1				Remove	
Legal Name						
Prefix	Given Name	Middle Name	Family Name	Suffix		
	Peter	John	COUSINS			
Residence Information (Select One) • US Residency Non US Residency Active US Military Service						
City	Menlo Park	State/Province	CA	Country of Residence	US	
Mailing Address of Inventor:						
Address 1		c/o SunPower Corporation				
Address 2		77 Rio Robles				
City	San Jose	State/Province	CA			
Postal Code	95134	Country	US			
All Inventors Must Be Listed - Additional Inventor Information blocks may be generated within this form by selecting the Add button.						
Add						

Correspondence Information:

Enter either Customer Number or complete the Correspondence Information section below. For further information see 37 CFR 1.33(a).	
☐ An Address is being provided for the correspondence Information of this application.	
Customer Number	74254
Email Address	
Add Email Remove Email	

Application Information:

Title of the Invention	FRONT CONTACT SOLAR CELL WITH FORMED EMITTER		
Attorney Docket Number	10031.004212	Small Entity Status Claimed	☐
Application Type	Nonprovisional		
Subject Matter	Utility		
Total Number of Drawing Sheets (if any)	7	Suggested Figure for Publication (if any)	

Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number.

Application Data Sheet 37 CFR 1.76		Attorney Docket Number	10031.004212
		Application Number	
Title of Invention	FRONT CONTACT SOLAR CELL WITH FORMED EMITTER		

Filing By Reference:

Only complete this section when filing an application by reference under 35 U.S.C. 111(c) and 37 CFR 1.57(a). Do not complete this section if application papers including a specification and any drawings are being filed. Any domestic benefit or foreign priority information must be provided in the appropriate section(s) below (i.e., "Domestic Benefit/National Stage Information" and "Foreign Priority Information").

For the purposes of a filing date under 37 CFR 1.53(b), the description and any drawings of the present application are replaced by this reference to the previously filed application, subject to conditions and requirements of 37 CFR 1.57(a).

Application number of the previously filed application	Filing date (YYYY-MM-DD)	Intellectual Property Authority or Country

Publication Information:

☐ Request Early Publication (Fee required at time of Request 37 CFR 1.219)

☐ **Request Not to Publish.** I hereby request that the attached application not be published under 35 U.S.C. 122(b) and certify that the invention disclosed in the attached application **has not and will not** be the subject of an application filed in another country, or under a multilateral international agreement, that requires publication at eighteen months after filing.

Representative Information:

Representative information should be provided for all practitioners having a power of attorney in the application. Providing this information in the Application Data Sheet does not constitute a power of attorney in the application (see 37 CFR 1.32). Either enter Customer Number or complete the Representative Name section below. If both sections are completed the customer Number will be used for the Representative Information during processing.

Please Select One:	☒ Customer Number	☐ US Patent Practitioner	☐ Limited Recognition (37 CFR 11.9)
Customer Number	74254		

Domestic Benefit/National Stage Information:

This section allows for the applicant to either claim benefit under 35 U.S.C. 119(e), 120, 121, 365(c), or 386(c) or indicate National Stage entry from a PCT application. Providing benefit claim information in the Application Data Sheet constitutes the specific reference required by 35 U.S.C. 119(e) or 120, and 37 CFR 1.78.

When referring to the current application, please leave the "Application Number" field blank.

Prior Application Status	Pending	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
	Continuation of	14/504771	2014-10-02

Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number.

Application Data Sheet 37 CFR 1.76		Attorney Docket Number		10031.004212	
		Application Number			
Title of Invention	FRONT CONTACT SOLAR CELL WITH FORMED EMITTER				
Prior Application Status		Patented		Remove	
Application Number	Continuity Type	Prior Application Number	Filing Date (YYYY-MM-DD)	Patent Number	Issue Date (YYYY-MM-DD)
14/504771	Continuation of	13/495577	2012-06-13	8878053	2014-11-04
Prior Application Status		Patented		Remove	
Application Number	Continuity Type	Prior Application Number	Filing Date (YYYY-MM-DD)	Patent Number	Issue Date (YYYY-MM-DD)
13/495577	Division of	12/070742	2008-02-20	8222516	2012-07-17
Additional Domestic Benefit/National Stage Data may be generated within this form by selecting the Add button.					Add

Foreign Priority Information:

This section allows for the applicant to claim priority to a foreign application. Providing this information in the application data sheet constitutes the claim for priority as required by 35 U.S.C. 119(b) and 37 CFR 1.55. When priority is claimed to a foreign application that is eligible for retrieval under the priority document exchange program (PDX)ⁱ the information will be used by the Office to automatically attempt retrieval pursuant to 37 CFR 1.55(i)(1) and (2). Under the PDX program, applicant bears the ultimate responsibility for ensuring that a copy of the foreign application is received by the Office from the participating foreign intellectual property office, or a certified copy of the foreign priority application is filed, within the time period specified in 37 CFR 1.55(g)(1).

			Remove
Application Number	Country ^j	Filing Date (YYYY-MM-DD)	Access Code ^j (if applicable)
Additional Foreign Priority Data may be generated within this form by selecting the Add button.			Add

Statement under 37 CFR 1.55 or 1.78 for AIA (First Inventor to File) Transition Applications

This application (1) claims priority to or the benefit of an application filed before March 16, 2013 and (2) also contains, or contained at any time, a claim to a claimed invention that has an effective filing date on or after March 16, 2013.

☐ NOTE: By providing this statement under 37 CFR 1.55 or 1.78, this application, with a filing date on or after March 16, 2013, will be examined under the first inventor to file provisions of the AIA.

Application Data Sheet 37 CFR 1.76		Attorney Docket Number	10031.004212
		Application Number	
Title of Invention	FRONT CONTACT SOLAR CELL WITH FORMED EMITTER		

Authorization or Opt-Out of Authorization to Permit Access:

When this Application Data Sheet is properly signed and filed with the application, applicant has provided written authority to permit a participating foreign intellectual property (IP) office access to the instant application-as-filed (see paragraph A in subsection 1 below) and the European Patent Office (EPO) access to any search results from the instant application (see paragraph B in subsection 1 below).

Should applicant choose not to provide an authorization identified in subsection 1 below, applicant **must opt-out** of the authorization by checking the corresponding box A or B or both in subsection 2 below.

NOTE: This section of the Application Data Sheet is **ONLY** reviewed and processed with the **INITIAL** filing of an application. After the initial filing of an application, an Application Data Sheet cannot be used to provide or rescind authorization for access by a foreign IP office(s). Instead, Form PTO/SB/39 or PTO/SB/69 must be used as appropriate.

1. Authorization to Permit Access by a Foreign Intellectual Property Office(s)

A. Priority Document Exchange (PDX) - Unless box A in subsection 2 (opt-out of authorization) is checked, the undersigned hereby **grants the USPTO authority** to provide the European Patent Office (EPO), the Japan Patent Office (JPO), the Korean Intellectual Property Office (KIPO), the State Intellectual Property Office of the People's Republic of China (SIPO), the World Intellectual Property Organization (WIPO), and any other foreign intellectual property office participating with the USPTO in a bilateral or multilateral priority document exchange agreement in which a foreign application claiming priority to the instant patent application is filed, access to: (1) the instant patent application-as-filed and its related bibliographic data, (2) any foreign or domestic application to which priority or benefit is claimed by the instant application and its related bibliographic data, and (3) the date of filing of this Authorization. See 37 CFR 1.14(h)(1).

B. Search Results from U.S. Application to EPO - Unless box B in subsection 2 (opt-out of authorization) is checked, the undersigned hereby **grants the USPTO authority** to provide the EPO access to the bibliographic data and search results from the instant patent application when a European patent application claiming priority to the instant patent application is filed. See 37 CFR 1.14(h)(2).

The applicant is reminded that the EPO's Rule 141(1) EPC (European Patent Convention) requires applicants to submit a copy of search results from the instant application without delay in a European patent application that claims priority to the instant application.

2. Opt-Out of Authorizations to Permit Access by a Foreign Intellectual Property Office(s)

☐ A. Applicant **DOES NOT** authorize the USPTO to permit a participating foreign IP office access to the instant application-as-filed. If this box is checked, the USPTO will not be providing a participating foreign IP office with any documents and information identified in subsection 1A above.

☐ B. Applicant **DOES NOT** authorize the USPTO to transmit to the EPO any search results from the instant patent application. If this box is checked, the USPTO will not be providing the EPO with search results from the instant application.

NOTE: Once the application has published or is otherwise publicly available, the USPTO may provide access to the application in accordance with 37 CFR 1.14.

Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number.

Application Data Sheet 37 CFR 1.76		Attorney Docket Number	10031.004212
		Application Number	
Title of Invention	FRONT CONTACT SOLAR CELL WITH FORMED EMITTER		

Applicant Information:

Providing assignment information in this section does not substitute for compliance with any requirement of part 3 of Title 37 of CFR to have an assignment recorded by the Office.

Applicant 1

Remove

If the applicant is the inventor (or the remaining joint inventor or inventors under 37 CFR 1.45), this section should not be completed. The information to be provided in this section is the name and address of the legal representative who is the applicant under 37 CFR 1.43; or the name and address of the assignee, person to whom the inventor is under an obligation to assign the invention, or person who otherwise shows sufficient proprietary interest in the matter who is the applicant under 37 CFR 1.46. If the applicant is an applicant under 37 CFR 1.46 (assignee, person to whom the inventor is obligated to assign, or person who otherwise shows sufficient proprietary interest) together with one or more joint inventors, then the joint inventor or inventors who are also the applicant should be identified in this section.

Clear

● Assignee

Legal Representative under 35 U.S.C. 117

Joint Inventor

Person to whom the inventor is obligated to assign.

Person who shows sufficient proprietary interest

If applicant is the legal representative, indicate the authority to file the patent application, the inventor is:

Name of the Deceased or Legally Incapacitated Inventor:

If the Applicant is an Organization check here.



Organization Name

SunPower Corporation

Mailing Address Information For Applicant:

Address 1

77 Rio Robles

Address 2

City

San Jose

State/Province

CA

Country

US

Postal Code

95134

Phone Number

Fax Number

Email Address

Additional Applicant Data may be generated within this form by selecting the Add button.

Add

Assignee Information including Non-Applicant Assignee Information:

Providing assignment information in this section does not substitute for compliance with any requirement of part 3 of Title 37 of CFR to have an assignment recorded by the Office.

Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number.

Application Data Sheet 37 CFR 1.76		Attorney Docket Number	10031.004212
		Application Number	
Title of Invention	FRONT CONTACT SOLAR CELL WITH FORMED EMITTER		

Assignee	1		
Complete this section if assignee information, including non-applicant assignee information, is desired to be included on the patent application publication. An assignee-applicant identified in the "Applicant Information" section will appear on the patent application publication as an applicant. For an assignee-applicant, complete this section only if identification as an assignee is also desired on the patent application publication.			
Remove			
If the Assignee or Non-Applicant Assignee is an Organization check here. ☒			
Organization Name	SunPower Corporation		
Mailing Address Information For Assignee including Non-Applicant Assignee:			
Address 1	77 Rio Robles		
Address 2			
City	San Jose	State/Province	CA
Country ⁱ	US	Postal Code	95134
Phone Number		Fax Number	
Email Address			
Additional Assignee or Non-Applicant Assignee Data may be generated within this form by selecting the Add button. Add			

Signature:[Remove](#)

NOTE: This Application Data Sheet must be signed in accordance with 37 CFR 1.33(b). However, if this Application Data Sheet is submitted with the **INITIAL** filing of the application and either box A or B is **not** checked in subsection 2 of the "Authorization or Opt-Out of Authorization to Permit Access" section, then this form must also be signed in accordance with 37 CFR 1.14(c).

This Application Data Sheet **must** be signed by a patent practitioner if one or more of the applicants is a **juristic entity** (e.g., corporation or association). If the applicant is two or more joint inventors, this form must be signed by a patent practitioner, **all** joint inventors who are the applicant, or one or more joint inventor-applicants who have been given power of attorney (e.g., see USPTO Form PTO/AIA/81) on behalf of **all** joint inventor-applicants.

See 37 CFR 1.4(d) for the manner of making signatures and certifications.

Signature	/Patrick D. Benedicto/		Date (YYYY-MM-DD)	2019-07-02	
First Name	PATRICK D.	Last Name	BENEDICTO	Registration Number	40909
Additional Signature may be generated within this form by selecting the Add button. Add					

Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number.

Application Data Sheet 37 CFR 1.76		Attorney Docket Number	10031.004212
		Application Number	
Title of Invention	FRONT CONTACT SOLAR CELL WITH FORMED EMITTER		

This collection of information is required by 37 CFR 1.76. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 23 minutes to complete, including gathering, preparing, and submitting the completed application data sheet form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

Privacy Act Statement

The Privacy Act of 1974 (P.L. 93-579) requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C. 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether the Freedom of Information Act requires disclosure of these records.
2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.
3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.
4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).
5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.
6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).
7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.
8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspections or an issued patent.
9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.



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UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NUMBER	FILING or 371(c) DATE	GRP ART UNIT	FIL FEE REC'D	ATTY. DOCKET NO	TOT CLAIMS	IND CLAIMS
16/460,035	07/02/2019	1757	0.00	10031.004212	20	3

CONFIRMATION NO. 5633

FILING RECEIPT



0000000109709821

74254

Okamoto & Benedicto LLP
P.O. Box 641330
San Jose, CA 95164-1330

Date Mailed: 07/17/2019

Receipt is acknowledged of this non-provisional utility patent application. The application will be taken up for examination in due course. Applicant will be notified as to the results of the examination. Any correspondence concerning the application must include the following identification information: the U.S. APPLICATION NUMBER, FILING DATE, NAME OF FIRST INVENTOR, and TITLE OF INVENTION. Fees transmitted by check or draft are subject to collection.

Please verify the accuracy of the data presented on this receipt. If an error is noted on this Filing Receipt, please submit a written request for a corrected Filing Receipt, including a properly marked-up ADS showing the changes with strike-through for deletions and underlining for additions. If you received a "Notice to File Missing Parts" or other Notice requiring a response for this application, please submit any request for correction to this Filing Receipt with your reply to the Notice. When the USPTO processes the reply to the Notice, the USPTO will generate another Filing Receipt incorporating the requested corrections provided that the request is grantable.

Inventor(s)

Peter John COUSINS, Menlo Park, CA;

Applicant(s)

SunPower Corporation, San Jose, CA;

Assignment For Published Patent Application

SunPower Corporation, San Jose, CA

Power of Attorney: The patent practitioners associated with Customer Number 74254

Domestic Priority data as claimed by applicant

This application is a CON of 14/504,771 10/02/2014
which is a CON of 13/495,577 06/13/2012 PAT 8878053
which is a DIV of 12/070,742 02/20/2008 PAT 8222516

Foreign Applications for which priority is claimed (You may be eligible to benefit from the **Patent Prosecution Highway** program at the USPTO. Please see <http://www.uspto.gov> for more information.) - None.

Foreign application information must be provided in an Application Data Sheet in order to constitute a claim to foreign priority. See 37 CFR 1.55 and 1.76.

Permission to Access Application via Priority Document Exchange: Yes

Permission to Access Search Results: Yes

Applicant may provide or rescind an authorization for access using Form PTO/SB/39 or Form PTO/SB/69 as appropriate.

If Required, Foreign Filing License Granted: 07/17/2019

The country code and number of your priority application, to be used for filing abroad under the Paris Convention, is **US 16/460,035**

Projected Publication Date: To Be Determined - pending completion of Missing Parts

Non-Publication Request: No

Early Publication Request: No

Title

FRONT CONTACT SOLAR CELL WITH FORMED EMITTER

Preliminary Class

136

Statement under 37 CFR 1.55 or 1.78 for AIA (First Inventor to File) Transition Applications: No

PROTECTING YOUR INVENTION OUTSIDE THE UNITED STATES

Since the rights granted by a U.S. patent extend only throughout the territory of the United States and have no effect in a foreign country, an inventor who wishes patent protection in another country must apply for a patent in a specific country or in regional patent offices. Applicants may wish to consider the filing of an international application under the Patent Cooperation Treaty (PCT). An international (PCT) application generally has the same effect as a regular national patent application in each PCT-member country. The PCT process **simplifies** the filing of patent applications on the same invention in member countries, but **does not result** in a grant of "an international patent" and does not eliminate the need of applicants to file additional documents and fees in countries where patent protection is desired.

Almost every country has its own patent law, and a person desiring a patent in a particular country must make an application for patent in that country in accordance with its particular laws. Since the laws of many countries differ in various respects from the patent law of the United States, applicants are advised to seek guidance from specific foreign countries to ensure that patent rights are not lost prematurely.

Applicants also are advised that in the case of inventions made in the United States, the Director of the USPTO must issue a license before applicants can apply for a patent in a foreign country. The filing of a U.S. patent application serves as a request for a foreign filing license. The application's filing receipt contains further information and guidance as to the status of applicant's license for foreign filing.

Applicants may wish to consult the USPTO booklet, "General Information Concerning Patents" (specifically, the section entitled "Treaties and Foreign Patents") for more information on timeframes and deadlines for filing foreign patent applications. The guide is available either by contacting the USPTO Contact Center at 800-786-9199, or it can be viewed on the USPTO website at <http://www.uspto.gov/web/offices/pac/doc/general/index.html>.

For information on preventing theft of your intellectual property (patents, trademarks and copyrights), you may wish to consult the U.S. Government website, <http://www.stopfakes.gov>. Part of a Department of Commerce initiative, this website includes self-help "toolkits" giving innovators guidance on how to protect intellectual property in specific

page 2 of 4

countries such as China, Korea and Mexico. For questions regarding patent enforcement issues, applicants may call the U.S. Government hotline at 1-866-999-HALT (1-866-999-4258).

LICENSE FOR FOREIGN FILING UNDER
Title 35, United States Code, Section 184
Title 37, Code of Federal Regulations, 5.11 & 5.15

GRANTED

The applicant has been granted a license under 35 U.S.C. 184, if the phrase "IF REQUIRED, FOREIGN FILING LICENSE GRANTED" followed by a date appears on this form. Such licenses are issued in all applications where the conditions for issuance of a license have been met, regardless of whether or not a license may be required as set forth in 37 CFR 5.15. The scope and limitations of this license are set forth in 37 CFR 5.15(a) unless an earlier license has been issued under 37 CFR 5.15(b). The license is subject to revocation upon written notification. The date indicated is the effective date of the license, unless an earlier license of similar scope has been granted under 37 CFR 5.13 or 5.14.

This license is to be retained by the licensee and may be used at any time on or after the effective date thereof unless it is revoked. This license is automatically transferred to any related applications(s) filed under 37 CFR 1.53(d). This license is not retroactive.

The grant of a license does not in any way lessen the responsibility of a licensee for the security of the subject matter as imposed by any Government contract or the provisions of existing laws relating to espionage and the national security or the export of technical data. Licensees should apprise themselves of current regulations especially with respect to certain countries, of other agencies, particularly the Office of Defense Trade Controls, Department of State (with respect to Arms, Munitions and Implements of War (22 CFR 121-128)); the Bureau of Industry and Security, Department of Commerce (15 CFR parts 730-774); the Office of Foreign Assets Control, Department of Treasury (31 CFR Parts 500+) and the Department of Energy.

NOT GRANTED

No license under 35 U.S.C. 184 has been granted at this time, if the phrase "IF REQUIRED, FOREIGN FILING LICENSE GRANTED" DOES NOT appear on this form. Applicant may still petition for a license under 37 CFR 5.12, if a license is desired before the expiration of 6 months from the filing date of the application. If 6 months has lapsed from the filing date of this application and the licensee has not received any indication of a secrecy order under 35 U.S.C. 181, the licensee may foreign file the application pursuant to 37 CFR 5.15(b).

SelectUSA

The United States represents the largest, most dynamic marketplace in the world and is an unparalleled location for business investment, innovation, and commercialization of new technologies. The U.S. offers tremendous resources and advantages for those who invest and manufacture goods here. Through SelectUSA, our nation works to promote and facilitate business investment. SelectUSA provides information assistance to the international investor community; serves as an ombudsman for existing and potential investors; advocates on behalf of U.S. cities, states, and regions competing for global investment; and counsels U.S. economic development organizations on investment attraction best practices. To learn more about why the United States is the best country in the world to develop

technology, manufacture products, deliver services, and grow your business, visit <http://www.SelectUSA.gov> or call +1-202-482-6800.

PATENT APPLICATION FEE DETERMINATION RECORD Substitute for Form PTO-875						Application or Docket Number 16/460,035				
APPLICATION AS FILED - PART I										
(Column 1)		(Column 2)		SMALL ENTITY		OR OTHER THAN SMALL ENTITY				
FOR	NUMBER FILED	NUMBER EXTRA	RATE(\$)	FEE(\$)		RATE(\$)	FEE(\$)			
BASIC FEE (37 CFR 1.16(a), (b), or (c))	N/A	N/A	N/A			N/A	300			
SEARCH FEE (37 CFR 1.16(k), (l), or (m))	N/A	N/A	N/A			N/A	660			
EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A	N/A			N/A	760			
TOTAL CLAIMS (37 CFR 1.16(i))	20	minus 20 = *				x 100 =	0.00			
INDEPENDENT CLAIMS (37 CFR 1.16(h))	3	minus 3 = *				x 460 =	0.00			
APPLICATION SIZE FEE (37 CFR 1.16(s))	If the specification and drawings exceed 100 sheets of paper, the application size fee due is \$310 (\$155 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).						0.00			
MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))							0.00			
* If the difference in column 1 is less than zero, enter "0" in column 2.			TOTAL			TOTAL	1720			
APPLICATION AS AMENDED - PART II										
(Column 1)		(Column 2)		(Column 3)		SMALL ENTITY		OR OTHER THAN SMALL ENTITY		
AMENDMENT A		CLAIMS REMAINING AFTER AMENDMENT		HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA	RATE(\$)	ADDITIONAL FEE(\$)		RATE(\$)	ADDITIONAL FEE(\$)
	Total (37 CFR 1.16(i))	*	Minus	**	=	x	=		x	=
	Independent (37 CFR 1.16(h))	*	Minus	***	=	x	=		x	=
	Application Size Fee (37 CFR 1.16(s))									
	FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))									
						TOTAL ADD'L FEE			TOTAL ADD'L FEE	
AMENDMENT B		CLAIMS REMAINING AFTER AMENDMENT		HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA	RATE(\$)	ADDITIONAL FEE(\$)		RATE(\$)	ADDITIONAL FEE(\$)
	Total (37 CFR 1.16(i))	*	Minus	**	=	x	=		x	=
	Independent (37 CFR 1.16(h))	*	Minus	***	=	x	=		x	=
	Application Size Fee (37 CFR 1.16(s))									
	FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))									
						TOTAL ADD'L FEE			TOTAL ADD'L FEE	
* If the entry in column 1 is less than the entry in column 2, write "0" in column 3. ** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20". *** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3". The "Highest Number Previously Paid For" (Total or Independent) is the highest found in the appropriate box in column 1.										



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APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
16/460,035	07/02/2019	Peter John COUSINS	10031.004212

CONFIRMATION NO. 5633

FORMALITIES LETTER



OC000000109709822

74254
Okamoto & Benedicto LLP
P.O. Box 641330
San Jose, CA 95164-1330

Date Mailed: 07/17/2019

NOTICE TO FILE MISSING PARTS OF NONPROVISIONAL APPLICATION

FILED UNDER 37 CFR 1.53(b)

Filing Date Granted

Items Required To Avoid Abandonment:

An application number and filing date have been accorded to this application. The item(s) indicated below, however, are missing. Applicant is given **TWO MONTHS** from the date of this Notice within which to file all required items below to avoid abandonment. Extensions of time may be obtained by filing a petition accompanied by the extension fee under the provisions of 37 CFR 1.136(a).

- The statutory basic filing fee is missing.
- The application search fee must be submitted.
- The application examination fee must be submitted.
- Surcharge as set forth in 37 CFR 1.16(f) must be submitted.

The surcharge is due for any one of:

- late submission of the basic filing fee, search fee, or examination fee,
- late submission of inventor's oath or declaration,
- filing an application that does not contain at least one claim on filing, or
- submission of an application filed by reference to a previously filed application.

SUMMARY OF FEES DUE:

The fee(s) required within **TWO MONTHS** from the date of this Notice to avoid abandonment is/are itemized below. No entity status discount is in effect. If applicant is qualified for small entity status, a written assertion of small entity status must be submitted to establish small entity status. (See 37 CFR 1.27). If applicant is qualified for micro entity status, an acceptable Certification of Micro Entity Status must be submitted to establish micro entity status. (See 37 CFR 1.29 and forms PTO/SB/15A and 15B.)

- \$ **300** basic filing fee.
- \$ **160** surcharge.
- \$ **660** search fee.
- \$ **760** examination fee.
- \$(**0**) previous unapplied payment amount.
- \$ **1880** TOTAL FEE BALANCE DUE.

Items Required To Avoid Processing Delays:

Applicant is notified that the above-identified application contains the deficiencies noted below. No period for reply is set forth in this notice for correction of these deficiencies. However, if a deficiency relates to the inventor's oath or declaration, the applicant must file an oath or declaration in compliance with 37 CFR 1.63, or a substitute statement in compliance with 37 CFR 1.64, executed by or with respect to each actual inventor no later than the expiration of the time period set in the "Notice of Allowability" to avoid abandonment. See 37 CFR 1.53(f).

- A properly executed inventor's oath or declaration has not been received for the following inventor(s):
Peter John COUSINS

Replies must be received in the USPTO within the set time period or must include a proper Certificate of Mailing or Transmission under 37 CFR 1.8 with a mailing or transmission date within the set time period. For more information and a suggested format, see Form PTO/SB/92 and MPEP 512.

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<https://portal.uspto.gov/authenticate/AuthenticateUserLocalEPF.html>

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If you are not using EFS-Web to submit your reply, you must include a copy of this notice.

Questions about the contents of this notice and the requirements it sets forth should be directed to the Office of Data Management, Application Assistance Unit, at (571) 272-4000 or (571) 272-4200 or 1-888-786-0101.

/hnguyen/

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

First Named Inventor:

Peter John COUSINS

Application No.: 16/460,035

Examiner: unknown

Filing Date: July 2, 2019

Art Unit: unknown

Title: FRONT CONTACT SOLAR CELL WITH FORMED EMITTER

PRELIMINARY AMENDMENT

INTRODUCTORY COMMENTS

Prior to examination, please enter the following amendments in the above-identified application.

AMENDMENTS TO THE CLAIMS

1-20 (canceled)

21. (New) A solar cell, the solar cell comprising:

a N-type silicon substrate having a front surface and a back surface, wherein the front surface comprises a textured surface;

an antireflective layer over the front surface of the N-type silicon substrate;

a doped region in the front surface of the N-type silicon substrate;

an oxide region disposed on the back surface of the N-type silicon substrate;

a polysilicon emitter disposed on the oxide region;

a first metal contact disposed on the front surface of the N-type silicon substrate, wherein the first metal contact is in electrical contact with the doped region; and

a second metal contact disposed on the polysilicon emitter.

22. (New) The solar cell of claim 21, wherein the antireflective layer comprises a layer of silicon nitride.

23. (New) The solar cell of claim 21, wherein the polysilicon emitter comprises a P-type doped polysilicon.

24. (New) The solar cell of claim 21, further comprising a dielectric layer over the polysilicon emitter.

25. (New) The solar cell of claim 24, wherein the dielectric layer comprises silicon dioxide.

26. (New) The solar cell of claim 24, further comprising a trench cutting through the dielectric layer and the polysilicon emitter and into a portion of the N-type silicon substrate on the backside of the solar cell.

27. (New) The solar cell of claim 21, wherein the second metal contact comprises a metal forming an infrared reflecting layer with a dielectric layer.
28. (New) The solar cell of claim 21, wherein the second metal contact comprises a metal formed in a plurality of contact holes to the polysilicon emitter.
29. (New) The solar cell of claim 21, wherein the first and second metal contacts comprise a metal selected from the group consisting of silver or aluminum.
30. (New) A solar cell, the solar cell comprising:
a substrate having a front surface and a back surface, wherein the front surface comprises a textured surface;
an antireflective layer over the front surface of the substrate;
a doped region in the front surface of the substrate;
an oxide region disposed on the back surface of the substrate;
a polysilicon emitter disposed on the oxide region;
a first bus bar disposed on the front surface of the substrate;
a first metal contact disposed on the front surface of the substrate, wherein the first metal contact is in electrical contact with, and perpendicular to, the first bus bar; and
a second metal contact disposed on the polysilicon emitter.
31. (New) The solar cell of claim 30, further comprising a second bus bar disposed on the front surface of the substrate, wherein the second bus bar is parallel to the first bus bar.
32. (New) The solar cell of claim 31, wherein the first metal contact is in electrical contact with, and perpendicular to, the first bus bar and the second bus bar.
33. (New) The solar cell of claim 31, further comprising a third bus bar disposed on the back surface of the substrate.

34. (New) The solar cell of claim 33, further comprising a fourth bus bar disposed on the back surface of the substrate, wherein the fourth bus bar is parallel to the third bus bar.
35. (New) The solar cell of claim 31, wherein the polysilicon emitter comprises a P-type doped polysilicon.
36. (New) A solar cell array, the solar cell array comprising:
a first solar cell, the first solar cell comprising:
a substrate having a front surface and a back surface, wherein the front surface comprises a textured surface;
an antireflective layer over the front surface of the substrate;
a doped region in the front surface of the substrate;
an oxide region disposed on the back surface of the substrate;
a polysilicon emitter disposed on the oxide region;
a first bus bar disposed on the front surface of the substrate, wherein the first bus bar is electrically connected to a corresponding bus bar of another solar cell;
a first metal contact disposed on the front surface of the N-type silicon substrate, wherein the first metal contact is in electrical contact with, and perpendicular to, the first bus bar; and
a second metal contact, disposed on the polysilicon emitter.
37. (New) The solar cell array of claim 36, further comprising a second bus bar disposed on the front surface of the first solar cell, wherein the second bus bar is parallel to the first bus bar.
38. (New) The solar cell of claim 37, wherein the first metal contact is in electrical contact with and perpendicular to the first bus bar and the second bus bar of the first solar cell.

39. (New) The solar cell of claim 37, further comprising a third bus bar disposed on the back surface of the first solar cell, wherein the third bus bar is electrically connected to a corresponding bus bar of another solar cell.

40. (New) The solar cell of claim 39, further comprising a fourth bus bar disposed on the back surface of the first solar cell, wherein the fourth bus bar is parallel to the third bus bar.

REMARKS

With the above amendments, claims 21-40 remain in the application.

This application is a continuing application of previous applications. No arguments or disclaimers made in the previous applications apply to this application and, consequently, it is asked that the Examiner review the new set of claims in view of all of the prior art of record and any search that the Examiner deems appropriate.

Respectfully submitted,

Dated: September 17, 2019

/Patrick D. Benedicto/
Patrick D. Benedicto, Reg. No. 40,909
Okamoto & Benedicto LLP
P.O. Box 641330
San Jose, CA 95164
Tel.: (408)436-2112
Fax.: (408)436-2114

Electronic Patent Application Fee Transmittal				
Application Number:		16460035		
Filing Date:		02-Jul-2019		
Title of Invention:		FRONT CONTACT SOLAR CELL WITH FORMED EMITTER		
First Named Inventor/Applicant Name:		Peter John COUSINS		
Filer:		Patrick D. Benedicto/Jina Mangaoang		
Attorney Docket Number:		10031.004212		
Filed as Large Entity				
Filing Fees for Utility under 35 USC 111(a)				
Description	Fee Code	Quantity	Amount	Sub-Total in USD(\$)
Basic Filing:				
UTILITY APPLICATION FILING	1011	1	300	300
UTILITY SEARCH FEE	1111	1	660	660
UTILITY EXAMINATION FEE	1311	1	760	760
Pages:				
Claims:				
Miscellaneous-Filing:				
LATE FILING FEE FOR OATH OR DECLARATION	1051	1	160	160
Petition:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD(\$)
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
Extension-of-Time:				
Miscellaneous:				
Total in USD (\$)				1880

Electronic Acknowledgement Receipt	
EFS ID:	37190620
Application Number:	16460035
International Application Number:	
Confirmation Number:	5633
Title of Invention:	FRONT CONTACT SOLAR CELL WITH FORMED EMITTER
First Named Inventor/Applicant Name:	Peter John COUSINS
Customer Number:	74254
Filer:	Patrick D. Benedicto/Jina Mangaoang
Filer Authorized By:	Patrick D. Benedicto
Attorney Docket Number:	10031.004212
Receipt Date:	17-SEP-2019
Filing Date:	02-JUL-2019
Time Stamp:	16:08:17
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	CARD
Payment was successfully received in RAM	\$1880
RAM confirmation Number	E20199GG08532951
Deposit Account	
Authorized User	

The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows:

File Listing:					
Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1		S0123US3_ResponseToNoticeOfMissingParts.pdf	430314	yes	9
			6b944a9f334b4057a8428788321e54c1115a8958		
	Multipart Description/PDF files in .zip description				
	Document Description		Start	End	
	Applicant Response to Pre-Exam Formalities Notice		1	3	
	Preliminary Amendment		4	4	
	Claims		5	8	
	Applicant Arguments/Remarks Made in an Amendment		9	9	
Warnings:					
Information:					
2	Fee Worksheet (SB06)	fee-info.pdf	37035	no	2
			7045e15e10bf597842c5ed34840582b14bc4c5e2		
Warnings:					
Information:					
Total Files Size (in bytes):			467349		

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of: Peter John COUSINS	Examiner: not yet known
Application No. 16/460,035	Art Unit: 1757
Filing Date: 07/02/2019	Attorney Docket No. 10031.004212
Title: FRONT CONTACT SOLAR CELL WITH FORMED EMITTER	

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Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

RESPONSE TO NOTICE TO FILE MISSING PARTS OF
NONPROVISIONAL APPLICATION

In response to the Notice to File Missing Parts of Nonprovisional Application mailed **07/17/2019** for the above-identified patent application, please find the following:

- ☒ A copy of the *Notice to File Missing Parts of Nonprovisional Application*; and
- ☒ Payment of **\$1,880.00** for the filing fees and surcharge.

Also attached is a Preliminary Amendment.

Favorable action is respectfully solicited.

Respectfully submitted,

Dated: September 17, 2019

/Patrick D. Benedicto/

Patrick D. Benedicto, Reg. No. 40,909
OKAMOTO & BENEDICTO LLP
P.O. Box 641330
San Jose, California 95164
(408) 436-2110

Enclosure(s)



UNITED STATES PATENT AND TRADEMARK OFFICE

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APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
16/460,035	07/02/2019	Peter John COUSINS	10031.004212

CONFIRMATION NO. 5633

FORMALITIES LETTER



0000000109709822

74254
Okamoto & Benedicto LLP
P.O. Box 641330
San Jose, CA 95164-1330

Date Mailed: 07/17/2019

NOTICE TO FILE MISSING PARTS OF NONPROVISIONAL APPLICATION

FILED UNDER 37 CFR 1.53(b)

Filing Date Granted

Items Required To Avoid Abandonment:

An application number and filing date have been accorded to this application. The item(s) indicated below, however, are missing. Applicant is given **TWO MONTHS** from the date of this Notice within which to file all required items below to avoid abandonment. Extensions of time may be obtained by filing a petition accompanied by the extension fee under the provisions of 37 CFR 1.136(a).

- The statutory basic filing fee is missing.
- The application search fee must be submitted.
- The application examination fee must be submitted.
- Surcharge as set forth in 37 CFR 1.16(f) must be submitted.

The surcharge is due for any one of:

- late submission of the basic filing fee, search fee, or examination fee,
- late submission of inventor's oath or declaration,
- filing an application that does not contain at least one claim on filing, or
- submission of an application filed by reference to a previously filed application.

SUMMARY OF FEES DUE:

The fee(s) required within **TWO MONTHS** from the date of this Notice to avoid abandonment is/are itemized below. No entity status discount is in effect. If applicant is qualified for small entity status, a written assertion of small entity status must be submitted to establish small entity status. (See 37 CFR 1.27). If applicant is qualified for micro entity status, an acceptable Certification of Micro Entity Status must be submitted to establish micro entity status. (See 37 CFR 1.29 and forms PTO/SB/15A and 15B.)

- \$ 300 basic filing fee.
- \$ 160 surcharge.
- \$ 660 search fee.
- \$ 760 examination fee.
- \$(0) previous unapplied payment amount.
- \$ 1880 TOTAL FEE BALANCE DUE.

Items Required To Avoid Processing Delays:

Applicant is notified that the above-identified application contains the deficiencies noted below. No period for reply is set forth in this notice for correction of these deficiencies. However, if a deficiency relates to the inventor's oath or declaration, the applicant must file an oath or declaration in compliance with 37 CFR 1.63, or a substitute statement in compliance with 37 CFR 1.64, executed by or with respect to each actual inventor no later than the expiration of the time period set in the "Notice of Allowability" to avoid abandonment. See 37 CFR 1.53(f).

- A properly executed inventor's oath or declaration has not been received for the following inventor(s):
Peter John COUSINS

Replies must be received in the USPTO within the set time period or must include a proper Certificate of Mailing or Transmission under 37 CFR 1.8 with a mailing or transmission date within the set time period. For more information and a suggested format, see Form PTO/SB/92 and MPEP 512.

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Registered users of EFS-Web may alternatively submit their reply to this notice via EFS-Web, including a copy of this Notice and selecting the document description "Applicant response to Pre-Exam Formalities Notice".
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For more information about EFS-Web please call the USPTO Electronic Business Center at 1-866-217-9197 or visit our website at <http://www.uspto.gov/ebc>.

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Questions about the contents of this notice and the requirements it sets forth should be directed to the Office of Data Management, Application Assistance Unit, at (571) 272-4000 or (571) 272-4200 or 1-888-786-0101.

/hnguyen/



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APPLICATION NUMBER	FILING or 371(c) DATE	GRP ART UNIT	FIL FEE REC'D	ATTY. DOCKET NO	TOT CLAIMS	IND CLAIMS
16/460,035	07/02/2019	1757	1880	10031.004212	20	3

CONFIRMATION NO. 5633

UPDATED FILING RECEIPT

74254

Okamoto & Benedicto LLP
P.O. Box 641330
San Jose, CA 95164-1330



0000000111233540

Date Mailed: 09/18/2019

Receipt is acknowledged of this non-provisional utility patent application. The application will be taken up for examination in due course. Applicant will be notified as to the results of the examination. Any correspondence concerning the application must include the following identification information: the U.S. APPLICATION NUMBER, FILING DATE, NAME OF FIRST INVENTOR, and TITLE OF INVENTION. Fees transmitted by check or draft are subject to collection.

Please verify the accuracy of the data presented on this receipt. If an error is noted on this Filing Receipt, please submit a written request for a corrected Filing Receipt, including a properly marked-up ADS showing the changes with strike-through for deletions and underlining for additions. If you received a "Notice to File Missing Parts" or other Notice requiring a response for this application, please submit any request for correction to this Filing Receipt with your reply to the Notice. When the USPTO processes the reply to the Notice, the USPTO will generate another Filing Receipt incorporating the requested corrections provided that the request is grantable.

Inventor(s)

Peter John COUSINS, Menlo Park, CA;

Applicant(s)

SunPower Corporation, San Jose, CA;

Assignment For Published Patent Application

SunPower Corporation, San Jose, CA

Power of Attorney: The patent practitioners associated with Customer Number 74254

Domestic Priority data as claimed by applicant

This application is a CON of 14/504,771 10/02/2014 ABN
which is a CON of 13/495,577 06/13/2012 PAT 8878053
which is a DIV of 12/070,742 02/20/2008 PAT 8222516

Foreign Applications for which priority is claimed (You may be eligible to benefit from the **Patent Prosecution Highway** program at the USPTO. Please see <http://www.uspto.gov> for more information.) - None.

Foreign application information must be provided in an Application Data Sheet in order to constitute a claim to foreign priority. See 37 CFR 1.55 and 1.76.

Permission to Access Application via Priority Document Exchange: Yes

Permission to Access Search Results: Yes

Applicant may provide or rescind an authorization for access using Form PTO/SB/39 or Form PTO/SB/69 as appropriate.

If Required, Foreign Filing License Granted: 07/17/2019

The country code and number of your priority application, to be used for filing abroad under the Paris Convention, is **US 16/460,035**

Projected Publication Date: 12/26/2019

Non-Publication Request: No

Early Publication Request: No

Title

FRONT CONTACT SOLAR CELL WITH FORMED EMITTER

Preliminary Class

136

Statement under 37 CFR 1.55 or 1.78 for AIA (First Inventor to File) Transition Applications: No

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Almost every country has its own patent law, and a person desiring a patent in a particular country must make an application for patent in that country in accordance with its particular laws. Since the laws of many countries differ in various respects from the patent law of the United States, applicants are advised to seek guidance from specific foreign countries to ensure that patent rights are not lost prematurely.

Applicants also are advised that in the case of inventions made in the United States, the Director of the USPTO must issue a license before applicants can apply for a patent in a foreign country. The filing of a U.S. patent application serves as a request for a foreign filing license. The application's filing receipt contains further information and guidance as to the status of applicant's license for foreign filing.

Applicants may wish to consult the USPTO booklet, "General Information Concerning Patents" (specifically, the section entitled "Treaties and Foreign Patents") for more information on timeframes and deadlines for filing foreign patent applications. The guide is available either by contacting the USPTO Contact Center at 800-786-9199, or it can be viewed on the USPTO website at <http://www.uspto.gov/web/offices/pac/doc/general/index.html>.

For information on preventing theft of your intellectual property (patents, trademarks and copyrights), you may wish to consult the U.S. Government website, <http://www.stopfakes.gov>. Part of a Department of Commerce initiative, this website includes self-help "toolkits" giving innovators guidance on how to protect intellectual property in specific

page 2 of 4

countries such as China, Korea and Mexico. For questions regarding patent enforcement issues, applicants may call the U.S. Government hotline at 1-866-999-HALT (1-866-999-4258).

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Title 35, United States Code, Section 184
Title 37, Code of Federal Regulations, 5.11 & 5.15

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This license is to be retained by the licensee and may be used at any time on or after the effective date thereof unless it is revoked. This license is automatically transferred to any related applications(s) filed under 37 CFR 1.53(d). This license is not retroactive.

The grant of a license does not in any way lessen the responsibility of a licensee for the security of the subject matter as imposed by any Government contract or the provisions of existing laws relating to espionage and the national security or the export of technical data. Licensees should apprise themselves of current regulations especially with respect to certain countries, of other agencies, particularly the Office of Defense Trade Controls, Department of State (with respect to Arms, Munitions and Implements of War (22 CFR 121-128)); the Bureau of Industry and Security, Department of Commerce (15 CFR parts 730-774); the Office of Foreign Assets Control, Department of Treasury (31 CFR Parts 500+) and the Department of Energy.

NOT GRANTED

No license under 35 U.S.C. 184 has been granted at this time, if the phrase "IF REQUIRED, FOREIGN FILING LICENSE GRANTED" DOES NOT appear on this form. Applicant may still petition for a license under 37 CFR 5.12, if a license is desired before the expiration of 6 months from the filing date of the application. If 6 months has lapsed from the filing date of this application and the licensee has not received any indication of a secrecy order under 35 U.S.C. 181, the licensee may foreign file the application pursuant to 37 CFR 5.15(b).

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APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
16/460,035	07/02/2019	Peter John COUSINS	10031.004212

CONFIRMATION NO. 5633

INFORMAL NOTICE



74254
Okamoto & Benedicto LLP
P.O. Box 641330
San Jose, CA 95164-1330

Date Mailed: 09/18/2019

INFORMATIONAL NOTICE TO APPLICANT

Applicant is notified that the above-identified application contains the deficiencies noted below. No period for reply is set forth in this notice for correction of these deficiencies. However, if a deficiency relates to the inventor's oath or declaration, the applicant must file an oath or declaration in compliance with 37 CFR 1.63, or a substitute statement in compliance with 37 CFR 1.64, executed by or with respect to each actual inventor no later than the expiration of the time period set in the "Notice of Allowability" to avoid abandonment. See 37 CFR 1.53(f).

The item(s) indicated below are also required and should be submitted with any reply to this notice to avoid further processing delays.

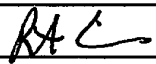
- A properly executed inventor's oath or declaration has not been received for the following inventor(s):
Peter John COUSINS

Questions about the contents of this notice and the requirements it sets forth should be directed to the Office of Data Management, Application Assistance Unit, at (571) 272-4000 or (571) 272-4200 or 1-888-786-0101.

/tnguyen/

PATENT APPLICATION FEE DETERMINATION RECORD Substitute for Form PTO-875						Application or Docket Number 16/460,035	
APPLICATION AS FILED - PART I							
(Column 1)		(Column 2)		SMALL ENTITY		OTHER THAN SMALL ENTITY	
FOR	NUMBER FILED	NUMBER EXTRA	RATE(\$)	FEE(\$)		RATE(\$)	FEE(\$)
BASIC FEE (37 CFR 1.16(a), (b), or (c))	N/A	N/A	N/A			N/A	300
SEARCH FEE (37 CFR 1.16(k), (l), or (m))	N/A	N/A	N/A			N/A	660
EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A	N/A			N/A	760
TOTAL CLAIMS (37 CFR 1.16(i))	20	minus 20 = *				x 100 =	0.00
INDEPENDENT CLAIMS (37 CFR 1.16(h))	3	minus 3 = *				x 460 =	0.00
APPLICATION SIZE FEE (37 CFR 1.16(s))	If the specification and drawings exceed 100 sheets of paper, the application size fee due is \$310 (\$155 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).						0.00
MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))							0.00
* If the difference in column 1 is less than zero, enter "0" in column 2.			TOTAL			TOTAL	1720
APPLICATION AS AMENDED - PART II							
(Column 1)		(Column 2)		(Column 3)		SMALL ENTITY	
AMENDMENT A	CLAIMS REMAINING AFTER AMENDMENT	MINUS	HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA	RATE(\$)	ADDITIONAL FEE(\$)	RATE(\$)
	Total (37 CFR 1.16(i))	*	Minus	**	=	x	=
	Independent (37 CFR 1.16(h))	*	Minus	***	=	x	=
	Application Size Fee (37 CFR 1.16(s))						
	FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))						
				TOTAL ADD'L FEE			TOTAL ADD'L FEE
(Column 1)		(Column 2)		(Column 3)		SMALL ENTITY	
AMENDMENT B	CLAIMS REMAINING AFTER AMENDMENT	MINUS	HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA	RATE(\$)	ADDITIONAL FEE(\$)	RATE(\$)
	Total (37 CFR 1.16(i))	*	Minus	**	=	x	=
	Independent (37 CFR 1.16(h))	*	Minus	***	=	x	=
	Application Size Fee (37 CFR 1.16(s))						
	FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))						
				TOTAL ADD'L FEE			TOTAL ADD'L FEE
* If the entry in column 1 is less than the entry in column 2, write "0" in column 3. ** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20". *** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3". The "Highest Number Previously Paid For" (Total or Independent) is the highest found in the appropriate box in column 1.							

DECLARATION (37 CFR 1.63) FOR UTILITY OR DESIGN APPLICATION USING AN APPLICATION DATA SHEET (37 CFR 1.76)

Title of Invention	FRONT CONTACT SOLAR CELL WITH FORMED EMITTER
As the below named inventor, I hereby declare that: This declaration is directed to: ☐ The attached application, or ☒ United States application or PCT international application number <u>16/460,035</u> filed on <u>07/02/2019</u> The above-identified application was made or authorized to be made by me. I believe that I am the original inventor or an original joint inventor of a claimed invention in the application. I hereby acknowledge that any willful false statement made in this declaration is punishable under 18 U.S.C. 1001 by fine or imprisonment of not more than five (5) years, or both. WARNING: Petitioner/applicant is cautioned to avoid submitting personal information in documents filed in a patent application that may contribute to identity theft. Personal information such as social security numbers, bank account numbers, or credit card numbers (other than a check or credit card authorization form PTO-2038 submitted for payment purposes) is never required by the USPTO to support a petition or an application. If this type of personal information is included in documents submitted to the USPTO, petitioners/applicants should consider redacting such personal information from the documents before submitting them to the USPTO. Petitioner/applicant is advised that the record of a patent application is available to the public after publication of the application (unless a non-publication request in compliance with 37 CFR 1.213(a) is made in the application) or issuance of a patent. Furthermore, the record from an abandoned application may also be available to the public if the application is referenced in a published application or an issued patent (see 37 CFR 1.14). Checks and credit card authorization forms PTO-2038 submitted for payment purposes are not retained in the application file and therefore are not publicly available. LEGAL NAME OF INVENTOR Inventor: <u>Peter John COUSINS</u> Date (Optional): <u>19th SEP 2019</u> Signature: <u></u> Note: An application data sheet (PTO/SB/14 or equivalent), including naming the entire inventive entity, must accompany this form or must have been previously filed. Use an additional PTO/AIA/01 form for each additional inventor.	

This collection of information is required by 35 U.S.C. 115 and 37 CFR 1.63. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 1 minute to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

Electronic Acknowledgement Receipt	
EFS ID:	37256829
Application Number:	16460035
International Application Number:	
Confirmation Number:	5633
Title of Invention:	FRONT CONTACT SOLAR CELL WITH FORMED EMITTER
First Named Inventor/Applicant Name:	Peter John COUSINS
Customer Number:	74254
Filer:	Patrick D. Benedicto/Jina Mangaoang
Filer Authorized By:	Patrick D. Benedicto
Attorney Docket Number:	10031.004212
Receipt Date:	24-SEP-2019
Filing Date:	02-JUL-2019
Time Stamp:	14:22:01
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment		no			
File Listing:					
Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1		S0123US3_ResponseToInformationalNoticeToApplicant.pdf	250976	yes	3
			e59512670a89022d38316d66548ec710f12a3f0d		

	Multipart Description/PDF files in .zip description		
	Document Description	Start	End
	Applicant Response to Pre-Exam Formalities Notice	1	2
	Oath or Declaration filed	3	3
Warnings:			
Information:			
Total Files Size (in bytes):		250976	
This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503. <u>New Applications Under 35 U.S.C. 111</u> If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application. <u>National Stage of an International Application under 35 U.S.C. 371</u> If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course. <u>New International Application Filed with the USPTO as a Receiving Office</u> If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.			

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of: Peter John COUSINS	Examiner: not yet known
Application No. 16/460,035	Art Unit: 1757
Filing Date: 07/02/2019	Attorney Docket No. 10031.004212
Title: FRONT CONTACT SOLAR CELL WITH FORMED EMITTER	

Commissioner for Patents
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RESPONSE TO INFORMATIONAL NOTICE TO APPLICANT

In response to the Informational Notice to Applicant mailed 09/18/2019 for the above-identified patent application, please find attached the following:

- ☒ Copy of the *Informational Notice to Applicant*; and
- ☒ Executed Declaration (PTO/AIA/01) from inventor, Peter John Cousins.

Favorable action is respectfully solicited.

Respectfully submitted,

Dated: September 24, 2019

/Patrick D. Benedicto/
Patrick D. Benedicto, Reg. No. 40,909
Attorney of Record
OKAMOTO & BENEDICTO LLP
(408) 436-2110; (408) 436-2114 (Fax)

Enclosure(s)



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APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
16/460,035	07/02/2019	Peter John COUSINS	10031.004212

CONFIRMATION NO. 5633

74254
Okamoto & Benedicto LLP
P.O. Box 641330
San Jose, CA 95164-1330

INFORMAL NOTICE



Date Mailed: 09/18/2019

INFORMATIONAL NOTICE TO APPLICANT

Applicant is notified that the above-identified application contains the deficiencies noted below. No period for reply is set forth in this notice for correction of these deficiencies. However, if a deficiency relates to the inventor's oath or declaration, the applicant must file an oath or declaration in compliance with 37 CFR 1.63, or a substitute statement in compliance with 37 CFR 1.64, executed by or with respect to each actual inventor no later than the expiration of the time period set in the "Notice of Allowability" to avoid abandonment. See 37 CFR 1.53(f).

The item(s) indicated below are also required and should be submitted with any reply to this notice to avoid further processing delays.

- A properly executed inventor's oath or declaration has not been received for the following inventor(s):
Peter John COUSINS

Questions about the contents of this notice and the requirements it sets forth should be directed to the Office of Data Management, Application Assistance Unit, at (571) 272-4000 or (571) 272-4200 or 1-888-786-0101.

/tnguyen/



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APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
16/460,035	07/02/2019	Peter John COUSINS	10031.004212

CONFIRMATION NO. 5633

PUBLICATION NOTICE



OC000000113552685

74254
Okamoto & Benedicto LLP
P.O. Box 641330
San Jose, CA 95164-1330

Title:FRONT CONTACT SOLAR CELL WITH FORMED EMITTER

Publication No.US-2019-0393368-A1

Publication Date:12/26/2019

NOTICE OF PUBLICATION OF APPLICATION

The above-identified application will be electronically published as a patent application publication pursuant to 37 CFR 1.211, et seq. The patent application publication number and publication date are set forth above.

The publication may be accessed through the USPTO's publicly available Searchable Databases via the Internet at www.uspto.gov. The direct link to access the publication is currently <http://www.uspto.gov/patft/>.

The publication process established by the Office does not provide for mailing a copy of the publication to applicant. A copy of the publication may be obtained from the Office upon payment of the appropriate fee set forth in 37 CFR 1.19(a)(1). Orders for copies of patent application publications are handled by the USPTO's Public Records Division. The Public Records Division can be reached by telephone at (571) 272-3150 or (800) 972-6382, by facsimile at (571) 273-3250, by mail addressed to the United States Patent and Trademark Office, Public Records Division, Alexandria, VA 22313-1450 or via the Internet.

In addition, information on the status of the application, including the mailing date of Office actions and the dates of receipt of correspondence filed in the Office, may also be accessed via the Internet through the Patent Electronic Business Center at www.uspto.gov using the public side of the Patent Application Information and Retrieval (PAIR) system. The direct link to access this status information is currently <https://portal.uspto.gov/pair/PublicPair>. Prior to publication, such status information is confidential and may only be obtained by applicant using the private side of PAIR.

Further assistance in electronically accessing the publication, or about PAIR, is available by calling the Patent Electronic Business Center at 1-866-217-9197.

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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
16/460,035	07/02/2019	Peter John COUSINS	10031.004212	5633
74254 7590 07/06/2020 Okamoto & Benedicto LLP (SunPower) P.O. Box 641330 San Jose, CA 95164-1330			EXAMINER PILLAY, DEVINA	
			ART UNIT 1726	PAPER NUMBER
			MAIL DATE 07/06/2020	DELIVERY MODE PAPER

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

DETAILED ACTION

Notice of Pre-AIA or AIA Status

The present application is being examined under the pre-AIA first to invent provisions.

Claim Rejections - 35 USC § 103

In the event the determination of the status of the application as subject to AIA 35 U.S.C. 102 and 103 (or as subject to pre-AIA 35 U.S.C. 102 and 103) is incorrect, any correction of the statutory basis for the rejection will not be considered a new ground of rejection if the prior art relied upon, and the rationale supporting the rejection, would be the same under either status.

The following is a quotation of pre-AIA 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

The factual inquiries set forth in *Graham v. John Deere Co.*, 383 U.S. 1, 148 USPQ 459 (1966), that are applied for establishing a background for determining obviousness under pre-AIA 35 U.S.C. 103(a) are summarized as follows:

1. Determining the scope and contents of the prior art.
2. Ascertaining the differences between the prior art and the claims at issue.
3. Resolving the level of ordinary skill in the pertinent art.
4. Considering objective evidence present in the application indicating obviousness or nonobviousness.

This application currently names joint inventors. In considering patentability of the claims under pre-AIA 35 U.S.C. 103(a), the examiner presumes that the subject matter of the various claims was commonly owned at the time any inventions covered therein were made absent any evidence to the contrary. Applicant is advised of the obligation under 37 CFR 1.56 to point out the inventor and invention dates of each claim that was not commonly owned at the time a later invention was made in order for the examiner to consider the applicability of pre-AIA 35 U.S.C. 103(c) and potential pre-AIA 35 U.S.C. 102(e), (f) or (g) prior art under pre-AIA 35 U.S.C. 103(a).

Claims 21-23 is/are rejected under pre-AIA 35 U.S.C. 103(a) as being unpatentable over Meier (US 6,262,359) in view of Okayasu (JP07-106611, Human Translation) in view of Borden (WO 2009/094578 A2) and in view of Wenham (6,429,037 B1) in view of Jordan (US 2005/0268963 A1).

Regarding claims 21 and 23, Meier discloses a solar cell comprising (see Fig. 3D, C5/L38-C6/L55):

a n-type silicon substrate (218 n-type, C5/L30-42) having a front surface that faces the sun to collect solar radiation during normal operation and a back surface opposite the front surface;

an anti-reflection (214) coating on the front surface of the solar cell;

an emitter (220 p-type) forming a backside junction with the substrate;

a front electrode disposed over the front surface of the substrate (212);

a back electrode disposed over the back surface of the substrate (222)

a front surface field region on the front surface (216 high doped concentration area n+), on the front surface of the substrate.

However, Meier does not disclose that there is a textured surface on the N-type silicon substrate on the front side of the solar cell.

Jordan discloses that the front surface of the solar cell is textured ([0022]). In addition, Jordan discloses that texturizing the front surface increases light absorption ([0022]).

It would have been obvious to one of ordinary skill in the art at the time of the invention to modify the front surface of Meier by texturizing the front surface as disclosed by Jordan because it increases light adsorption.

However, Meier does not disclose that the emitter is a polysilicon emitter or that the front surface field is formed of polysilicon and that there is a tunnel dielectric formed between the emitter and the back surface of the substrate or that there is a tunnel dielectric formed between the front surface field and the substrate.

Okayasu discloses that instead of forming an emitter **or** surface field from a portion of a substrate which is doped, an emitter or surface field can be formed using a doped polysilicon layer ([0005] [0009], Abstract) and by forming an emitter or surface field this way the thickness can be more accurately controlled and it prevents generation of floating foreign matter ([0008] [0009]).

It would have been obvious to one of ordinary skill in the art at the time of the invention to replace the method of forming the emitter/front surface field from a portion of a substrate of Meier and instead forming the emitter and front surface field by using a doped polysilicon layer as disclosed by Okayasu because the thickness can be more accurately controlled and it prevent generation of floating foreign matter.

However, modified Meier does not disclose a tunneling dielectric oxide between the emitter/front surface field and the substrate.

Borden discloses that tunnel oxides can be used in solar cells between doped polysilicon and monocrystalline substrates [0016] and can be formed on both the front and back surfaces of a monocrystalline substrate.

Furthermore, Borden discloses that by providing the tunneling layer it prevents epitaxial growth of the emitter layer and further it protects the surface from plasma damage of the deposited emitter layer [0015].

It would have been obvious to one of ordinary skill in the art at the time of the invention to modify the interface between polycrystalline layers and monocrystalline substrate back and front surfaces of modified Meier by having a tunneling oxide at the interfaces because it prevents epitaxial growth of the emitter layer and further it protects the crystalline surface from plasma damage of the deposited emitter layer.

Modified Meier discloses a first tunnel dielectric between the emitter and back surface and a second tunnel dielectric at the front surface of the substrate.

However, modified Meier does not disclose that doped region in the substrate.

Wenham discloses a solar cell wherein the area beneath point contacts includes areas of high doping which is important for reducing contact resistance (see Fig. 5, portions 18 and 23) (C1/L25-41).

It would have been obvious to one of ordinary skill in the art at the time of the invention to modify the front surface field formed in the substrate of modified Meier by adding in highly doped regions under the metallic contacts as disclosed by Wenham

because doing so reduces the contact resistance and will improve the efficiency of the solar cell.

Modified Meier now discloses a p-type polysilicon emitter and an n+-type polysilicon FSF.

Regarding claim 22, modified Meier discloses all of the claim limitations as set forth above.

In addition Meier discloses that the antireflective layer comprises silicon nitride (C6/L20-25).

Claims 24, 25, and 27-29 is/are rejected under pre-AIA 35 U.S.C. 103(a) as being unpatentable over Meier (US 6,262,359) in view of Okayasu (JP07-106611, Human Translation) in view of Borden (WO 2009/094578 A2) and in further view of Wenham (6,429,037 B1) in view of Jordan (US 2005/0268963 A1) as applied to claims 21-23 above and in further view of Agnostinelli (US 2009/0301557 A1).

Regarding claim 24, 25, 27, 28, modified Meier discloses all of the claim limitations as set forth above.

However, Meier does not disclose a dielectric over a polysilicon emitter.

Agnostinelli discloses a back contact structure which comprises a dielectric/passivation layer structure formed on the back surface of the solar cell which is patterned and back contacts touch the rear doped surface of the solar cell and a continuous back contact layer is formed over the dielectric (SiO₂ [0116])/passivation stack ([0049][0048][0116]).

It would have been obvious to one of ordinary skill at the time of the invention to modify the solar cell of Meier by having a dielectric/passivation layer structure formed

on the back surface of the solar cell which is patterned and back contacts touch the rear doped surface of the solar cell and a continuous back contact layer is formed over the dielectric as disclosed Agnostinelli because it will improve the reflection and absorption of light by the solar cell and furthermore improve the passivation of the rear surface.

Regarding claim 29, modified Meier discloses all of the claim limitations as set forth above.

Meier discloses that the front contact can be silver (212, C7/L10-15).

However, Meier does not disclose that the electrode that is in contact with the p-type polysilicon layer is silver.

Okayasu discloses that the back electrode on the polysilicon emitter is formed of a silver electrode [0044].

It would have been obvious to one of ordinary skill in the art at the time of the invention to replace the aluminum electrode of Meier with the silver electrode of Okayasu because one of ordinary skill in the art would have been able to carry out such a substitution, and the results would be reasonably predictable.

Claim 26 is/are rejected under pre-AIA 35 U.S.C. 103(a) as being unpatentable over Meier (US 6,262,359) in view of Okayasu (JP07-106611, Human Translation) in view of Borden (WO 2009/094578 A2) and in further view of Wenham (6,429,037 B1) in view of Jordan (US 2005/0268963 A1) in view of Agnostinelli (US 2009/0301557 A1) as applied to claims 24, 25, and 27-29 above and in further view of Russell (US 2008/0216893 A1) and in view of Kray (Study on the edge isolation of industrial silicon solar cells with waterjet-guided laser).

Regarding claim 26, modified Meier discloses all of the claim limitations as set forth above.

However, modified Meier does not disclose trench cutting through the dielectric layer and the polysilicon emitter and into a portion of the n-type silicon substrate on the back side of the substrate.

Russell discloses that edge isolations can be performed at different positions on the solar cell including back sides and serve to electrically isolate the front and rear solar cells from each other ([0042]).

Kray discloses an edge isolation process which includes cutting through the passivation layer, doped layer and part of the substrate (See Fig. 1).

It would have been obvious to one of ordinary skill in the art at the time of the invention to modify the solar cell of modified Meier by having the edge be isolated by cutting through the rear passivation layer, rear emitter layer and part of the substrate as disclosed by Russell and Kray because it will prevent a shunt between front and back surfaces.

Claims 30-40 is/are rejected under pre-AIA 35 U.S.C. 103(a) as being unpatentable over Meier (US 6,262,359) in view of Okayasu (JP07-106611, Human Translation) in view of Borden (WO 2009/094578 A2) and in view of Wenham (6,429,037 B1) in view of Jordan (US 2005/0268963 A1) in view of Tsunomura (US 2008/0121266 A1).

Regarding claims 30-35, Meier discloses a solar cell comprising (see Fig. 3D, C5/L38-C6/L55):

a n-type silicon substrate (218 n-type, C5/L30-42) having a front surface that faces the sun to collect solar radiation during normal operation and a back surface opposite the front surface;

an anti-reflection (214) coating on the front surface of the solar cell;

an emitter (220 p-type) forming a backside junction with the substrate;

a front electrode disposed over the front surface of the substrate (212);

a back electrode disposed over the back surface of the substrate (222)

a front surface field region on the front surface (216 high doped concentration area n+), on the front surface of the substrate.

However, Meier does not disclose that there is a textured surface on the N-type silicon substrate on the front side of the solar cell.

Jordan discloses that the front surface of the solar cell is textured ([0022]). In addition, Jordan discloses that texturizing the front surface increases light absorption ([0022]).

It would have been obvious to one of ordinary skill in the art at the time of the invention to modify the front surface of Meier by texturizing the front surface as disclosed by Jordan because it increases light adsorption.

However, Meier does not disclose that the emitter is a polysilicon emitter or that the front surface field is formed of polysilicon and that there is a tunnel dielectric formed between the emitter and the back surface of the substrate or that there is a tunnel dielectric formed between the front surface field and the substrate.

Okayasu discloses that instead of forming an emitter **or** surface field from a portion of a substrate which is doped, an emitter or surface field can be formed using a

doped polysilicon layer ([0005] [0009], Abstract) and by forming an emitter or surface field this way the thickness can be more accurately controlled and it prevents generation of floating foreign matter ([0008] [0009]).

It would have been obvious to one of ordinary skill in the art at the time of the invention to replace the method of forming the emitter/front surface field from a portion of a substrate of Meier and instead forming the emitter and front surface field by using a doped polysilicon layer as disclosed by Okayasu because the thickness can be more accurately controlled and it prevent generation of floating foreign matter.

However, modified Meier does not discloses a tunneling dielectric oxide between the emitter/front surface field and the substrate.

Borden discloses that tunnel oxides can be used in solar cells between doped polysilicon and monocrystalline substrates [0016] and can be formed on both the front and back surfaces of a monocrystalline substrate.

Furthermore, Borden discloses that by providing the tunneling layer it prevents epitaxial growth of the emitter layer and further it protects the surface from plasma damage of the deposited emitter layer [0015].

It would have been obvious to one of ordinary skill in the art at the time of the invention to modify the interface between polycrystalline layers and monocrystalline substrate back and front surfaces of modified Meier by having a tunneling oxide at the interfaces because it prevents epitaxial growth of the emitter layer and further it protects the crystalline surface from plasma damage of the deposited emitter layer.

Modified Meier discloses a first tunnel dielectric between the emitter and back surface and a second tunnel dielectric at the front surface of the substrate.

However, modified Meier does not disclose that doped region in the substrate.

Wenham discloses a solar cell wherein the area beneath point contacts includes areas of high doping which is important for reducing contact resistance (see Fig. 5, portions 18 and 23) (C1/L25-41).

It would have been obvious to one of ordinary skill in the art at the time of the invention to modify the front surface field formed in the substrate of modified Meier by adding in highly doped regions under the metallic contacts as disclosed by Wenham because doing so reduces the contact resistance and will improve the efficiency of the solar cell.

Modified Meier now discloses a p-type polysilicon emitter and an n+-type polysilicon FSF.

However, modified Meier does not disclose two bus bars on the front which run perpendicular to electrodes and two bus bars on the rear of the cell.

Tsunomura discloses two bus bars on the front (20) which run perpendicular to electrodes (30) and two bus bars on the rear of the cell (20) (see Figs. 2 and 3) ([0029][0030]).

It would have been obvious to one of ordinary skill in the art at the time of the invention to modify the solar cell of Meier so that there bus bars as disclosed by Tsunomura because it will improve the collection of photogenerated carriers because there are additional contacts and conductivity of the electrode.

Regarding claims 36-40, Meier discloses a solar cell comprising (see Fig. 3D, C5/L38-C6/L55):

a n-type silicon substrate (218 n-type, C5/L30-42) having a front surface that faces the sun to collect solar radiation during normal operation and a back surface opposite the front surface;

an anti-reflection (214) coating on the front surface of the solar cell;

an emitter (220 p-type) forming a backside junction with the substrate;

a front electrode disposed over the front surface of the substrate (212);

a back electrode disposed over the back surface of the substrate (222)

a front surface field region on the front surface (216 high doped concentration area n+), on the front surface of the substrate.

However, Meier does not disclose that there is a textured surface on the N-type silicon substrate on the front side of the solar cell.

Jordan discloses that the front surface of the solar cell is textured ([0022]). In addition, Jordan discloses that texturizing the front surface increases light absorption ([0022]).

It would have been obvious to one of ordinary skill in the art at the time of the invention to modify the front surface of Meier by texturizing the front surface as disclosed by Jordan because it increases light adsorption.

However, Meier does not disclose that the emitter is a polysilicon emitter or that the front surface field is formed of polysilicon and that there is a tunnel dielectric formed between the emitter and the back surface of the substrate or that there is a tunnel dielectric formed between the front surface field and the substrate.

Okayasu discloses that instead of forming an emitter **or** surface field from a portion of a substrate which is doped, an emitter or surface field can be formed using a

doped polysilicon layer ([0005] [0009], Abstract) and by forming an emitter or surface field this way the thickness can be more accurately controlled and it prevents generation of floating foreign matter ([0008] [0009]).

It would have been obvious to one of ordinary skill in the art at the time of the invention to replace the method of forming the emitter/front surface field from a portion of a substrate of Meier and instead forming the emitter and front surface field by using a doped polysilicon layer as disclosed by Okayasu because the thickness can be more accurately controlled and it prevent generation of floating foreign matter.

However, modified Meier does not discloses a tunneling dielectric oxide between the emitter/front surface field and the substrate.

Borden discloses that tunnel oxides can be used in solar cells between doped polysilicon and monocrystalline substrates [0016] and can be formed on both the front and back surfaces of a monocrystalline substrate.

Furthermore, Borden discloses that by providing the tunneling layer it prevents epitaxial growth of the emitter layer and further it protects the surface from plasma damage of the deposited emitter layer [0015].

It would have been obvious to one of ordinary skill in the art at the time of the invention to modify the interface between polycrystalline layers and monocrystalline substrate back and front surfaces of modified Meier by having a tunneling oxide at the interfaces because it prevents epitaxial growth of the emitter layer and further it protects the crystalline surface from plasma damage of the deposited emitter layer.

Modified Meier discloses a first tunnel dielectric between the emitter and back surface and a second tunnel dielectric at the front surface of the substrate.

However, modified Meier does not disclose that doped region in the substrate.

Wenham discloses a solar cell wherein the area beneath point contacts includes areas of high doping which is important for reducing contact resistance (see Fig. 5, portions 18 and 23) (C1/L25-41).

It would have been obvious to one of ordinary skill in the art at the time of the invention to modify the front surface field formed in the substrate of modified Meier by adding in highly doped regions under the metallic contacts as disclosed by Wenham because doing so reduces the contact resistance and will improve the efficiency of the solar cell.

Modified Meier now discloses a p-type polysilicon emitter and an n+-type polysilicon FSF.

However, modified Meier does not disclose two bus bars on the front which run perpendicular to electrodes and two bus bars on the rear of the cell.

Tsunomura discloses two bus bars on the front (20) which run perpendicular to electrodes (30) and two bus bars on the rear of the cell (20) (see Figs. 2 and 3) ([0029][0030]).

It would have been obvious to one of ordinary skill in the art at the time of the invention to modify the solar cell of Meier so that there bus bars as disclosed by Tsunomura because it will improve the collection of photogenerated carriers because there are additional contacts and conductivity of the electrode.

However, modified Meier does not disclose that the solar cell is part of an array of cells and they are interconnected.

Tsunomura discloses an array of solar cells that interconnected by attaching wiring to the bus bars on the back and front of solar cells (see Fig. 1, interconnect 40 and Fig. 4 [0016]).

It would have been obvious to one of ordinary skill in the art at the time of invention to modify the solar cell of modified Meier by including additional solar cells to form an array of solar cells and interconnecting them as disclosed by Tsunomura because doing so will harness more solar energy.

Conclusion

Any inquiry concerning this communication or earlier communications from the examiner should be directed to DEVINA PILLAY whose telephone number is (571)270-1180. The examiner can normally be reached on Monday-Friday 9:30-6:00.

Examiner interviews are available via telephone, in-person, and video conferencing using a USPTO supplied web-based collaboration tool. To schedule an interview, applicant is encouraged to use the USPTO Automated Interview Request (AIR) at <http://www.uspto.gov/interviewpractice>.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Jeffrey T Barton can be reached on 517-272-1307. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should

you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

DEVINA PILLAY
Primary Examiner
Art Unit 1726

/DEVINA PILLAY/
Primary Examiner, Art Unit 1726

<i>Notice of References Cited</i>	Application/Control No. 16/460,035		Applicant(s)/Patent Under Reexamination COUSINS, Peter John	
	Examiner DEVINA PILLAY		Art Unit 1726	Page 1 of 1

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Dates in MM-YYYY format are publication dates. Classifications may be US or foreign.

U.S. Patent and Trademark Office
PTO-892 (Rev. 01-2001)

Notice of References Cited

Part of Paper No. 20200526

Search Notes 	Application/Control No. 16/460,035	Applicant(s)/Patent Under Reexamination COUSINS, Peter John
	Examiner DEVINA PILLAY	Art Unit 1726

CPC - Searched*		
Symbol	Date	Examiner
H01L31/0236 H01L31/0745 H01L31/1804 H01L31/022425 H01L31/068 H01L31/182 H01L31/056; text limited	05/27/2020	DP

CPC Combination Sets - Searched*		
Symbol	Date	Examiner

US Classification - Searched*			
Class	Subclass	Date	Examiner

* See search history printout included with this form or the SEARCH NOTES box below to determine the scope of the search.

Search Notes		
Search Notes	Date	Examiner
Inventor name search in EAST	05/27/2020	DP
EAST Text Search (See Search History)	05/27/2020	DP

Interference Search			
US Class/CPC Symbol	US Subclass/CPC Group	Date	Examiner

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35 USC 119 (a-d) conditions met: ☐ Yes ☒ No

☐ Met After Allowance

Verified and Acknowledged: /DEVINA PILLAY/

Examiner's Signature

Initials

Title:

FRONT CONTACT SOLAR CELL WITH FORMED EMITTER

FILING or 371(c) DATE	CLASS	GROUP ART UNIT	ATTORNEY DOCKET NO.
07/02/2019	136	1726	10031.004212
RULE			

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CONTINUING DATA

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14504771 is a CON of 13495577 06/13/2012 PAT 8878053

13495577 is a DIV of 12070742 02/20/2008 PAT 8222516

FOREIGN APPLICATIONS

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TITLE: BSF type solar battery mfr. by forming poly:silicon@ layer on
N=type silicon substrate by CVD and using silicon fluoride as
etching gas

INVENTOR: OKAYASU Y; SAGAWA Y

PATENT-ASSIGNEE: TONEN CORP[TOFU]

PRIORITY-DATA: 1993JP-243040 (September 29, 1993)

PATENT-FAMILY:

PUB-NO	PUB-DATE	LANGUAGE
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JP <u>07106611</u>	A April 21, 1995	JA
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APPLICATION-DATA:

PUB-NO	APPL-DESCRIPTOR	APPL-NO	APPL-DATE
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JP 07106611A	N/A	1993JP-243040	September 29, 1993
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INT-CL-
CURRENT:

TYPE	IPC DATE
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CIPP	H01 L 31/04 20060101
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ABSTRACTED-PUB-NO: JP 07106611 A

BASIC-ABSTRACT:

The method involves forming a P type polysilicon layer (2) on the light incident side of a N type single crystal silicon substrate (1). Thus, a PN junction is formed. A N+ polysilicon layer (5) is set up at the opposite side of the silicon substrate and forms a HL junction. The N+ polysilicon layer is formed by CVD method which applies B₂H₆ or SiF₄ or SiH₄ gas onto the heated silicon substrate. When SiF₄ is used as an etching agent, a halogen radical emitted near the heated silicon substrate.

ADVANTAGE - The method prevents generation of floating foreign material in a room; reduces substrate temp. of BSF type solar battery; and enables mfr. of BSF type solar battery with high photoelectric conversion efficiency and high stability.

CHOSEN- Dwg.1/10
DRAWING:

TITLE-TERMS: TYPE SOLAR BATTERY MANUFACTURE FORMING POLY SILICON@ LAYER
N=TYPE SILICON SUBSTRATE CVD FLUORIDE ETCH GAS

ADDL-INDEXING- BACK SURFACE FIELD
TERMS:

DERWENT-CLASS: L03 U12 X15

CPI-CODES: L03-E05; L04-C02; L04-C10B;

EPI-CODES: U12-A02A3;

SECONDARY-ACC-NO:

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Non-CPI Secondary Accession Numbers: 1995-148457

(19) 日本国特許庁 (J P)

(12) 公開特許公報 (A)

(11) 特許出願公開番号

特開平7-106611

(43) 公開日 平成7年(1995)4月21日

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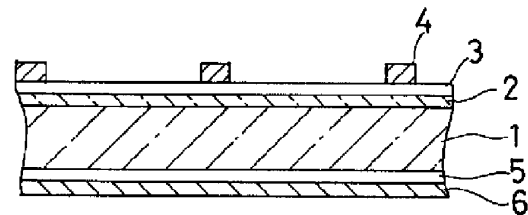
(54) 【発明の名称】 B S F 型太陽電池の製造方法

(57) 【要約】

【目的】 光電変換効率の高い B S F 型太陽電池を安定して製造できる方法を提供すること。

【構成】 n^- 単結晶シリコン (以下、Si) 基板 1 と、この光入射側面に設けられた p 型のポリ Si 層 2 と、反対側面に設けられ Si 基板との間で H L 接合を形成する n^+ ポリ Si 層 5 を備える B S F 型太陽電池の製造方法であり、上記 n^+ ポリ Si 層を $B_2H_6/SiH_4/SiF_4$ を原料ガスとする熱 C V D 法により形成することを特徴とする。この方法によれば、ハロゲン原子を放出する SiF_4 を適用しているにも拘らず製膜室内における浮遊異物の発生を防止でき、かつ、熱 C V D 法を適用しているにも拘らず基板加熱温度の低減を図ることが可能となるため、 n^+ ポリ Si 層の膜質が改善されて光電変換効率の高い B S F 型太陽電池を安定して製造できる効果を有している。

1: n^- 単結晶シリコン基板
2: p 型ポリシリコン層
5: n^+ ポリシリコン層



【特許請求の範囲】

【請求項1】 n型又はp型シリコン基板と、このシリコン基板の光入射面側に設けられシリコン基板との間でpn接合を形成するp型又はn型シリコン層と、上記シリコン基板の反対面に設けられシリコン基板との間でHL接合を形成するn⁺又はp⁺シリコン層とを備えるBSF型太陽電池の製造方法において、

n型又はp型シリコン基板を配置した製膜室内にシリコン原子が含まれる製膜ガスとSiH_mF_{4-m}（但しmは1～3）で示されるフッ素化シランガス及びn型又はp型のドーパントガスを供給し、かつ、上記供給ガスを加熱されたシリコン基板近傍で熱分解させると共に、熱分解された製膜ガスのラジカル成分と上記SiH_mF_{4-m}ガスとの反応により生じたフッ素系ラジカルをエッチング成分として作用させながらn型又はp型シリコン基板面に上記n⁺又はp⁺シリコン層を形成することを特徴とするBSF型太陽電池の製造方法。

【請求項2】 n型又はp型シリコン基板と、このシリコン基板の光入射面側に設けられシリコン基板との間でpn接合を形成するp型又はn型シリコン層と、上記シリコン基板の反対面に設けられシリコン基板との間でHL接合を形成するn⁺又はp⁺シリコン層とを備えるBSF型太陽電池の製造方法において、

n型又はp型シリコン基板を配置した製膜室内に水素化珪素を主成分とする製膜ガスとSiH_mF_{4-m}（但しmは1～3）で示されるフッ素化シランガス及びn型又はp型のドーパントガスを供給し、かつ、上記供給ガスを加熱されたシリコン基板近傍で熱分解させると共に、フッ素化シランガスの熱分解により生じたフッ素系ラジカル、及び、熱分解された製膜ガスのラジカル成分が上記フッ素化シランガスと反応して生じたフッ素系ラジカルをエッチング成分として作用させながらn型又はp型シリコン基板面に上記n⁺又はp⁺シリコン層を形成することを特徴とするBSF型太陽電池の製造方法。

【請求項3】 製膜室内に配置されたn型又はp型シリコン基板近傍の空間部位に上記基板が覆われるように網状の発熱部材を配置したことを特徴とする請求項1又は2記載のBSF型太陽電池の製造方法。

【請求項4】 n型又はp型シリコン基板と、このシリコン基板の光入射面側に設けられシリコン基板との間でpn接合を形成するp型又はn型シリコン層と、上記シリコン基板の反対面に設けられシリコン基板との間でHL接合を形成するn⁺又はp⁺シリコン層とを備えるBSF型太陽電池の製造方法において、

加熱されたシリコン基板面に上記n⁺又はp⁺シリコン層を光CVD法により形成することを特徴とするBSF型太陽電池の製造方法。

【請求項5】 n型又はp型シリコン基板と、このシリコン基板の光入射面側に設けられシリコン基板との間でpn接合を形成するp型又はn型シリコン層と、上記シリコン基板の反対面に設けられシリコン基板との間でHL

接合を形成するn⁺又はp⁺シリコン層とを備えるBSF型太陽電池の製造方法において、

n型又はp型シリコン基板を配置した製膜室内にSiH_mF_{4-m}（但しmは1～3）で示されるフッ素化シランガス又はSiF₄ガスを供給し、かつ、このフッ素化シランガス又はSiF₄ガスが存在する条件下においてイオンプレーティング法により加熱されたシリコン基板面に上記n⁺又はp⁺シリコン層を形成することを特徴とするBSF型太陽電池の製造方法。

10 【発明の詳細な説明】

【0001】

【産業上の利用分野】 本発明はBSF（Back Surface Field）型太陽電池の製造方法に係り、特に、光電変換効率の高いBSF型太陽電池を安定して製造できるBSF型太陽電池の製造方法に関するものである。

【0002】

【従来の技術】 この種のBSF型太陽電池としては、例えば、図7～8に示すようにp型単結晶シリコン基板aと、このシリコン基板aの光入射面側に設けられシリコン基板aとの間でpn接合を形成するn⁺シリコン層bと、このn⁺シリコン層b上に一様に成膜されたITO（酸化インジウム錫）の反射防止層cと、この反射防止層c上に設けられた櫛歯状電極dと、上記シリコン基板aの反対側面に設けられシリコン基板aとの間でHL（High-Low）接合を形成するp⁺シリコン層eと、このp⁺シリコン層eの背面側に一様に設けられた裏面電極fとでその主要部が構成され、光入射に伴って発生した電子とホールが上記電極d、fから電流として取出される構造のものが知られている。

20 【0003】 尚、図9はこのBSF型太陽電池の構造をモデル的に記載した構造概念図であり、また、図10はこの構造を有するBSF型太陽電池のエネルギーバンド図を示している。

【0004】 そして、p⁺シリコン層eを具備しない構造の太陽電池と較べてこのBSF型太陽電池においては、HL接合gを形成するシリコン基板aとp⁺シリコン層e間に存在する内蔵電界が少数キャリア（この場合、電子）の裏面電極fへの拡散の障壁となり見掛け上電子の拡散長が増加し、かつ上記p⁺シリコン層eがホールに対して低抵抗のオーム性電極になるためシリーズ抵抗が低下し、従って、その光電変換効率を向上できる利点を有するものであるとされている。

【0005】 ところで、開放電圧を上昇させる上記p⁺シリコン層eについては、従来「熱拡散法」により形成されていた。すなわち、B（ボロン）等を含むp型ドーパントガスで満たされた反応室内に上記単結晶シリコン基板aを導入し、このドーパントガスをシリコン基板a内に1000℃前後の高温条件下で熱拡散させて形成したり、単結晶シリコン基板a面にAl（アルミニウム）

等のp型ドーパント層を積層しこれを1000℃前後の高温条件下で焼成してp⁺シリコン層eを形成していた。

【0006】しかし、この『熱拡散法』によりp⁺シリコン層eを形成した場合、p⁺シリコン層eの厚み制御が難しくその層厚が数百オングストローム～数μmと大きくなり易く、かつ、熱的条件の僅かなばらつきでB、A1等ドーパントガスの拡散距離が変動し易いためシリコン基板aの特性がばらつき易い欠点があった。

【0007】更に、上記『熱拡散法』ではドーパントガスの回り込みも起こり易く、シリコン基板との間でp-n接合を形成するn⁺シリコン層b内へも上記ドーパントガスが熱拡散してしまうことがあり、また、シリコン基板が1000℃前後の高温に晒されることから基板の熱劣化を引起す等の欠点もあった。

【0008】このような技術的背景の下、本出願人は上記n型又はp型シリコン基板との間でHL接合を形成するn⁺シリコン層又はp⁺シリコン層をプラズマCVD法により形成するBSF型太陽電池の製造方法を既に提案している。すなわち、この製造方法によれば、従来の熱拡散法による場合に較べてn⁺シリコン層又はp⁺シリコン層形成時における熱的条件が緩和されるためシリコン基板の特性劣化が起こり難くなると共に、上記n⁺シリコン層又はp⁺シリコン層の厚さを従来より薄い数十オングストローム～数百オングストローム程度に形成することが可能になるためその光電変換効率の向上が図れる利点を有する方法であった。

【0009】

【発明が解決しようとする課題】ところで、プラズマCVD法を適用した上記製造方法においてはn⁺シリコン層又はp⁺シリコン層の低温製膜とその薄膜化が図れることから上述した利点を有していたが、その反面、上記n⁺シリコン層又はp⁺シリコン層の製膜工程中において粉状の浮遊異物が製膜室内に多量に発生し易く、この浮遊異物が製膜途上のn⁺シリコン層又はp⁺シリコン層内に混入されてその膜特性を劣化させてしまう欠点があった。

【0010】すなわち、プラズマCVD法を適用したこの製造方法においては製膜室内のプラズマ形成領域にプラズマ化された原料ガスが一樣に分布しかつこのプラズマ化された原料ガスは励起状態にあるため、製膜室内の任意の空間において原料ガスが互いに反応してシリコンの粉状体を生成したり、基板以外の部位すなわち製膜室内の内壁面においてプラズマ化された原料ガスが反応してシリコンが析出しこれが粉状体となって剥離する等粉状の浮遊異物が多量に発生し易い状態にある。

【0011】また、プラズマCVD法においては製膜ガスであるSiH₄ガス等に加えてハロゲンガスを配合する場合があります、このハロゲン原子のエッチング作用により製膜室内の内壁面や内部治具表面が腐食され易いためこ

の腐食面が剥離して上記浮遊異物に加わることになる。

【0012】このため、プラズマCVD法を適用した上記製造方法においては上述した利点を有している反面、良質なn⁺シリコン層又はp⁺シリコン層を形成することが困難なためこれに起因して得られたBSF型太陽電池の光電変換効率も一定の限界を有する問題点があった。

【0013】本発明はこのような問題点に着目してなされたもので、その課題とするところは、低温製膜条件で良質なn⁺シリコン層又はp⁺シリコン層が形成できる熱CVD法、光CVD法、及び、イオンプレーティング法を選択することにより光電変換効率が更に向上したBSF型太陽電池を安定して製造できる方法を提供することにある。

【0014】

【課題を解決するための手段】すなわち、請求項1に係る発明は、n型又はp型シリコン基板と、このシリコン基板の光入射面側に設けられシリコン基板との間でp-n接合を形成するp型又はn型シリコン層と、上記シリコン基板の反対面に設けられシリコン基板との間でHL接合を形成するn⁺又はp⁺シリコン層とを備えるBSF型太陽電池の製造方法を前提とし、n型又はp型シリコン基板を配置した製膜室内にシリコン原子が含まれる製膜ガスとSiF₄ガス及びn型又はp型のドーパントガスを供給し、かつ、上記供給ガスを加熱されたシリコン基板近傍で熱分解させると共に、熱分解された製膜ガスのラジカル成分と上記SiF₄ガスとの反応により生じたフッ素系ラジカルをエッチング成分として作用させながらn型又はp型シリコン基板に上記n⁺又はp⁺シリコン層を形成することを特徴とするものであり、また、請求項2に係る発明は、n型又はp型シリコン基板と、このシリコン基板の光入射面側に設けられシリコン基板との間でp-n接合を形成するp型又はn型シリコン層と、上記シリコン基板の反対面に設けられシリコン基板との間でHL接合を形成するn⁺又はp⁺シリコン層とを備えるBSF型太陽電池の製造方法を前提とし、n型又はp型シリコン基板を配置した製膜室内に水素化珪素を主成分とする製膜ガスとSiH_mF_{4-m}（但しmは1～3）で示されるフッ素化シランガス及びn型又はp型のドーパントガスを供給し、かつ、上記供給ガスを加熱されたシリコン基板近傍で熱分解させると共に、フッ素化シランガスの熱分解により生じたフッ素系ラジカル、及び、熱分解された製膜ガスのラジカル成分が上記フッ素化シランガスと反応して生じたフッ素系ラジカルをエッチング成分として作用させながらn型又はp型シリコン基板に上記n⁺又はp⁺シリコン層を形成することを特徴とするものである。

【0015】そして、請求項1に係る発明においてはハロゲン原子を放出するガスとして熱分解を受け難いSiF₄ガスが適用されており、また、請求項2に係る発明においてはハロゲン原子を放出するガスとして上記製膜

ガスよりその熱分解温度が高いフッ素化シランガスを適用しているため、製膜室内の基板から離れた温度分布の低い領域においては SiF_4 及びフッ素化シランガスの熱分解が起り難く、その分、この領域のフッ素系ラジカル濃度は低い状態になっている。

【0016】従って、プラズマCVD法を適用した従来の製造方法に較べて、製膜室内の任意の空間において上記製膜ガスがフッ素系ラジカルと反応してシリコン粉状体を生成したり、あるいは、製膜室内の内壁面や内部治具表面が上記フッ素系ラジカル作用を受けて腐食される可能性が低いため、ハロゲン原子を放出する SiF_4 又はフッ素化シランガスを適用しているにも拘らず製膜室内における浮遊異物の発生を防止することが可能となる。

【0017】一方、請求項1に係る発明において上記 SiF_4 ガスは熱分解を受けにくい反面、熱分解されたシラン化合物等製膜ガスのラジカル成分との反応によりその熱分解が促進されるため、上記ラジカル成分の多い領域、すなわちn型又はp型シリコン基板近傍領域において分解を受け易くこの領域に高濃度のフッ素系ラジカルが偏在することになる。また、請求項2に係る発明においても上記 SiH_2F_2 等フッ素化シランガスはn型又はp型シリコン基板近傍の高濃度領域において熱分解を受け易いと共に、熱分解された製膜ガスのラジカル成分(SiH_x ラジカル、 H 系ラジカル等)との反応によりその分解が促進されるため、基板近傍領域に高濃度のフッ素系ラジカルが偏在することになる。

【0018】従って、このフッ素系ラジカル作用によりn型又はp型シリコン基板上若しくは成長中の n^+ 又は p^+ シリコン層に混入された不純物のみが選択的にエッチングを受けて取除かれることになるため、本来、この不純物を取除くための高温加熱処理が必要となる熱CVD法を適用しているにも拘らず請求項1又は2に係る発明においては基板加熱温度の低減が図れる。

【0019】尚、請求項1又は2に係る発明において製膜室内の基板近傍の空間部位に上記基板を加熱する発熱手段を設けると、製膜ガスの熱分解が促進されるため基板加熱温度を更に低減することが可能となる。請求項3に係る発明はこのような技術的理由に基づきなされている。

【0020】すなわち、請求項3に係る発明は、請求項1又は2記載の発明に係るBSF型太陽電池の製造方法を前提とし、製膜室内に配置されたn型又はp型シリコン基板近傍の空間部位に上記基板が覆われるように網状の発熱部材を配置したことを特徴とするものである。

【0021】そして、n型又はp型シリコン基板近傍の空間部位に配置される上記発熱部材とは、基板全面を覆うように配置されても n^+ 又は p^+ シリコン層の製膜に支障を来さないような形状を備え、かつ水素化珪素等の製膜ガスを基板近傍領域で熱分解させる程度に発熱する材

料で構成されているもので、具体例としてタングステン、トリウムタングステン等から成る網状の熱フィラメントが挙げられる。

【0022】また、請求項1〜3に係る発明の熱CVD法においては、製膜処理中にこの製膜室内の真空度を略一定に維持するためその下流側において継続して排気処理を行っており、エッチング作用に供されたフッ素系ラジカルあるいは余剰のフッ素系ラジカルは上記排気処理により製膜室から外部へ排除されている。

【0023】ここで、請求項1〜3に係る発明においてn型又はp型シリコン基板との間でHL接合を形成する n^+ シリコン層又は p^+ シリコン層としては、n型又はp型ドーパントガスが導入されたアモルファスシリコン層、ポリシリコン層、あるいは、単結晶シリコン層が適用できる。この場合、内部抵抗を下げる観点からポリシリコン層よりはその抵抗値の低い単結晶シリコン層が望ましく、また、アモルファスシリコン層よりはその抵抗値の低いポリシリコン層が望ましい。

【0024】尚、n型のドーパントガスとしては元素周期率表第III族の Sb (アンチモン)、 As (ヒ素)、及び、 P (リン)等を含む化合物が適用でき、具体例としては、 SbH_3 、 SbCl_3 、 AsH_3 、 As_2H_4 、及び、 PH_3 等が挙げられる。また、p型のドーパントガスとしては元素周期率表第V族の Ga (ガリウム)、 B (ボロン)、 In (インジウム)、及び、 Al (アルミニウム)等を含む化合物が適用でき、具体例としては、 B_2H_6 、 $\text{Ga}(\text{CH}_3)_3$ 、 $\text{In}(\text{CH}_3)_3$ 、及び、 $\text{Al}(\text{CH}_3)_3$ 等が挙げられる。

【0025】また、請求項1又は3に係る発明においてシリコン原子が含まれる上記製膜ガスとしては、熱分解され易い SiH_4 、 Si_2H_6 、及び、 Si_3H_8 等の水素化珪素や $\text{SiH}_m\text{X}_{4-m}$ (但し、 m は1〜3、好ましくは2〜3、 X は Cl 又は F 原子、好ましくは F 原子である)で示されるハロゲン化シラン等が適用できる。尚、この製膜ガス内に水素ガスを添加してもよい。この水素系ラジカルも SiF_4 ガスに作用してその分解を促進させるからである。ここで、製膜ガスとして後者のハロゲン化シランガスを適用した場合、このハロゲン化シランガスの配合割合が高過ぎると製膜室内に上述した浮遊異物が生ずることがある。従って、 $\text{SiH}_m\text{X}_{4-m}$ で示されるハロゲン化シランガスを適用する場合にはその配合割合を上記 SiF_4 より少なく設定することが望ましい。

【0026】また、請求項2又は3に係る発明において上記製膜ガスの主要部を構成する水素化珪素としては、 SiH_4 、 Si_2H_6 、及び、 Si_3H_8 等が適用できる。また、請求項1又は3に係る発明と同様、上記製膜ガス内に水素ガスを添加してもよい。この水素系ラジカルも上記 SiH_2F_2 等のフッ素化シランガスと反応しその熱分解を促進させるからである。

【0027】尚、請求項1〜3に係る発明において上記

製膜ガス中に希釈ガスとして、ヘリウム、ネオン、アルゴン等の不活性ガスを加えてもよい。

【0028】そして、請求項1～3記載の発明に係るBSF型太陽電池の製造方法においては、製膜開始前における製膜室の真空度をこの製膜室内に不純物が若干残留する程度（ 10^{-5} Torr程度）に設定し、かつ、配置されたn型又はp型シリコン基板の温度を500℃～700℃程度に設定した後、少なくとも上記製膜ガスとSiF₄ガス及びn型又はp型のドーパントガスを供給するか、あるいは、少なくとも上記製膜ガスとSiH_mF_{4-m}（但しmは1～3）で示されるフッ素化シランガス及びn型又はp型のドーパントガスを供給して上記n型又はp型シリコン基板上にn⁺又はp⁺シリコン層を形成する。このとき、基板加熱温度を500℃～700℃程度の低温条件に設定しても上記フッ素系ラジカルのエッチング作用により不純物は選択的に除去され、また、浮遊異物の発生も殆ど起らずn⁺又はp⁺シリコン層内への混入が起こり難いため上記n⁺又はp⁺シリコン層の膜特性に悪影響を及ぼす可能性がほとんどない。

【0029】従って、光電変換効率が更に向上したBSF型太陽電池を安定して製造できる利点を有している。

【0030】次に、請求項4～5に係る発明は、請求項1～3に係る発明においてn⁺又はp⁺シリコン層の製膜に適用された熱CVD法に代えて光CVD法及びイオンプレーティング法を適用したBSF型太陽電池の製造方法に関する。

【0031】まず、請求項4に係る発明は、n型又はp型シリコン基板と、このシリコン基板の光入射面側に設けられシリコン基板との間でpn接合を形成するp型又はn型シリコン層と、上記シリコン基板の反対面に設けられシリコン基板との間でHL接合を形成するn⁺又はp⁺シリコン層とを備えるBSF型太陽電池の製造方法を前提とし、加熱されたシリコン基板面上に上記n⁺又はp⁺シリコン層を光CVD法により形成することを特徴とするものである。

【0032】すなわち、この光CVD装置は、図5に示すように製膜室11と、この製膜室11内に石英窓30を介し配設された紫外線照射ランプ31と、この紫外線照射ランプ31の対向側に設けられヒータ15が組込まれた基板ホルダー13と、製膜室11内へSiH₄等の製膜ガスと、適宜ドーパントガスと、水素ガス等を供給するガス供給源16、17と、調圧弁19を介して接続された減圧ポンプ18とでその主要部が構成されており、上記製膜室11内にn型又はp型シリコン基板14を配置すると共に、このシリコン基板14を500～600℃程度に加熱した後、上記ガス供給源16、17から製膜ガス、ドーパントガス等を供給し、かつ、紫外線を照射して上記n型又はp型シリコン基板14上にn⁺又はp⁺シリコン層を形成する方法である。

【0033】そして、この請求項4記載の発明に係る製

造方法によれば、低温製膜条件で膜質良好なn⁺又はp⁺シリコン層をp型シリコン基板14上に形成できるため、請求項1～3に係る発明と同様、光電変換効率が更に向上したBSF型太陽電池を安定して製造できる利点を有している。

【0034】次に、請求項5に係る発明は、n型又はp型シリコン基板と、このシリコン基板の光入射面側に設けられシリコン基板との間でpn接合を形成するp型又はn型シリコン層と、上記シリコン基板の反対面に設けられシリコン基板との間でHL接合を形成するn⁺又はp⁺シリコン層とを備えるBSF型太陽電池の製造方法を前提とし、n型又はp型シリコン基板を配置した製膜室内にSiH_mF_{4-m}（但しmは1～3）で示されるフッ素化シランガス又はSiF₄ガスを供給し、かつ、このフッ素化シランガス又はSiF₄ガスが存在する条件下においてイオンプレーティング法により加熱されたシリコン基板面上に上記n⁺又はp⁺シリコン層を形成することを特徴とするものである。

【0035】すなわち、このイオンプレーティング装置は、図6に示すように製膜室11と、この製膜室11内の下方側に設けられ製膜材料であるドーパント混入のSiターゲットが収容された抵抗加熱蒸発源40と、この抵抗加熱蒸発源40の上方側空間部に設けられたRFコイル41と、上記抵抗加熱蒸発源40からの供給量を調整するシャッター42と、製膜室11内の上方側に設けられシリコン基板14を600～700℃程度に加熱する基板ホルダー43とでその主要部が構成されており、かつ、RFコイル41には高周波電源44が、また、基板ホルダー43には正の高圧電源（図示せず）が接続されている。そして、上記製膜室11内にn型又はp型シリコン基板14を配置し、かつ、この製膜室11内にフッ素化シランガス又はSiF₄ガスを供給すると共に、上記シリコン基板14を600～700℃程度に加熱した後、抵抗加熱蒸発源40からドーパントとシリコンを蒸発させてn型又はp型シリコン基板14上にn⁺又はp⁺シリコン層を形成する方法である。

【0036】この請求項5に係る発明においても、請求項1～3に係る発明と同様、ハロゲン原子を放出するガスとして熱分解を受け難いフッ素化シランガス又はSiF₄ガスが適用されているためn型又はp型シリコン基板近傍領域において高濃度のフッ素系ラジカルが偏在することになる。すなわち、n型又はp型シリコン基板の近傍領域においては熱分解されたシリコン分子のラジカル成分が偏在しているため、このラジカル成分と上記フッ素化シランガス又はSiF₄ガスとの反応により高濃度のフッ素系ラジカルが偏在している。そして、このフッ素系ラジカル作用によりn型又はp型シリコン基板上若しくは成長中のn⁺又はp⁺シリコン層に混入された不純物のみが選択的にエッチングを受けて取除かれることになるため、低温製膜条件で膜質良好なn⁺又はp⁺シ

リコン層をn型又はp型シリコン基板上に形成することが可能となり、請求項1〜4に係る発明と同様、光電変換効率が更に向上したBSF型太陽電池を安定して製造できる利点を有している。

【0037】

【作用】請求項1に係る発明によれば、ハロゲン原子を放出するガスとして熱分解を受け難い SiF_4 ガスが適用されており、このガスが熱分解され難い分、製膜室内におけるフッ素系ラジカル濃度は低い状態になっているため、プラズマCVD法を適用した従来の製造方法に較べて製膜室内の任意の空間において製膜ガスがフッ素系ラジカルと反応してシリコン粉状体を生成したり、あるいは、製膜室内の内壁面や内部治具表面が上記フッ素系ラジカル作用を受けて腐食される可能性が極端に低くなり、ハロゲン原子を放出する SiF_4 ガスを適用しているにも拘らず製膜室内における浮遊異物の発生を確実に防止することが可能となる。

【0038】一方、上記 SiF_4 ガスは製膜ガスのラジカル成分(SiH_x ラジカル、H系ラジカル等)との反応によりその熱分解が促進されることからこのラジカル成分の多いn型又はp型シリコン基板近傍領域に高濃度のフッ素系ラジカルが偏在し易くなり、このフッ素系ラジカル作用により上記基板上若しくは成長中の n^+ 又は p^+ シリコン層に混入された不純物のみが選択的にエッチンを受けて取除かれるため、本来、この不純物を取除くための高温加熱処理が必要となる熱CVD法を適用しているにも拘らず基板加熱温度の低減を図ることが可能となる。

【0039】また、請求項2に係る発明によれば、ハロゲン原子を放出するガスとして上記製膜ガスよりその熱分解温度が高いフッ素化シランガスを適用しており、製膜室内の基板から離れた温度分布の低い領域においては上記製膜ガスに較べてこのフッ素化シランガスの熱分解が起り難くフッ素系ラジカル濃度は低い状態になっているため、プラズマCVD法を適用した従来の製造方法に較べて製膜室内の任意の空間において製膜ガスがフッ素系ラジカルと反応してシリコン粉状体を生成したり、あるいは、製膜室内の内壁面や内部治具表面が上記フッ素系ラジカル作用を受けて腐食される可能性が低くなり、ハロゲン原子を放出するフッ素化シランガスを適用しているにも拘らず製膜室内における浮遊異物の発生を防止することが可能となる。

【0040】一方、上記フッ素化シランガスはn型又はp型シリコン基板近傍の高温領域において熱分解を受け易いと共に熱分解された製膜ガスのラジカル成分(SiH_x ラジカル、H系ラジカル等)との反応によりその分解が促進されることからn型又はp型シリコン基板近傍領域に高濃度のフッ素系ラジカルが偏在し易くなり、このフッ素系ラジカル作用により上記基板上若しくは成長中の n^+ 又は p^+ シリコン層に混入された不純物のみが

選択的にエッチンを受けて取除かれるため、請求項1に係る発明と同様、熱CVD法を適用しているにも拘らず基板加熱温度の低減を図ることが可能となる。

【0041】更に、請求項3に係る発明によれば、製膜室内に配置されたn型又はp型シリコン基板近傍の空間部位に上記基板が覆われるように網状の発熱部材を配置していることから、この発熱部材が発する熱エネルギー的作用により上記基板近傍領域においては製膜ガスの熱分解が著しく促進されているため、上記フッ素系ラジカルのエッチング作用と相乗して基板加熱温度を更に低減させることが可能となる。

【0042】次に、請求項4に係る発明によれば、加熱されたシリコン基板面に n^+ 又は p^+ シリコン層を光CVD法により製膜しているため、低温製膜条件で膜質良好な n^+ 又は p^+ シリコン層を上記n型又はp型シリコン基板上に形成することが可能となる。

【0043】また、請求項5に係る発明によれば、フッ素化シランガス又は SiF_4 ガスが存在する条件下においてイオンプレーティング法により加熱されたシリコン基板面上に上記 n^+ 又は p^+ シリコン層を製膜しているため、低温製膜条件で膜質良好な n^+ 又は p^+ シリコン層を上記n型又はp型シリコン基板上に形成することが可能となる。

【0044】

【実施例】以下、本発明の実施例について詳細に説明するとこの実施例に係るBSF型太陽電池は、従来同様、図1に示すようにn-単結晶シリコン基板(100配向、比抵抗 $1\sim 10\Omega\cdot\text{cm}$)1と、このシリコン基板1の光入射側面に設けられシリコン基板1との間でpn接合を形成するp型アモルファスシリコン又はポリシリコン層2と、このp型アモルファスシリコン又はポリシリコン層2上に一様に成膜されITO(酸化インジウム錫)にて形成された反射防止層3と、この反射防止層3上に設けられ銀ペーストにて形成された櫛歯状電極4と、上記シリコン基板1の反対側面に設けられシリコン基板1との間でHL接合を形成する n^+ アモルファスシリコン又はポリシリコン層5と、この n^+ アモルファスシリコン又はポリシリコン層5の背面側に一様に設けられアルミニウムにて形成された裏面電極6とでその主要部が構成されているものである。

【0045】そしてこのBSF型太陽電池は以下の工程に従って製造されたものである。

【0046】[実施例1]図3はこの実施例で適用された熱CVD装置の概略構成を示した説明図で、図中11は製膜室、13はヒータ15が組込まれた基板ホルダー、14はこの基板ホルダー13に取付けられたn-単結晶シリコン基板、16、17は原料ガスの供給源、及び、18は調圧弁19を介し製膜室11に接続された減圧ポンプをそれぞれ示している。

【0047】まず、この製膜室11を排気して 1×10

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$^{-5}$ Torrの真空にし、次いで、この製膜室11内に下記原料ガスを導入すると共に下記の製膜条件に従ってその一面側にp型ポリシリコン層2を、他方の面にn⁺ポリシリコン層5をそれぞれ製膜した(図2A参照)。

【0048】(p型ポリシリコン層2の製膜条件)

原料ガスの種類と組成: $B_2H_6/SiH_4/SiF_4 = 0.1/10/500$

原料ガスの供給速度: $5\text{ sccm} \sim 100\text{ sccm}$

原料ガスの圧力: $50\text{ mtorr} \sim 1\text{ torr}$

n⁻単結晶シリコン基板の加熱温度: 700°C

(n⁺ポリシリコン層5の製膜条件)

原料ガスの種類と組成: $PH_3/SiH_4/SiF_4 = 0.1/10/330$

原料ガスの供給速度: $5\text{ sccm} \sim 100\text{ sccm}$

原料ガスの圧力: $50\text{ mtorr} \sim 1\text{ torr}$

n⁻単結晶シリコン基板の加熱温度: 700°C

次に、図2(B)に示すようにスパッタリング法にてp型ポリシリコン層2上にITOを着膜させて反射防止層3を形成し、かつ、この面上に銀ペーストにより櫛歯状電極4を形成すると共に、n⁺ポリシリコン層5の背面側にスパッタリング法によりアルミニウムを一樣に製膜して裏面電極6を形成し実施例に係るBSF型太陽電池を求めた(図1参照)。

【0049】そして、この電池の特性を調べたところ、n⁺ポリシリコン層の製膜手段にプラズマCVD法を適用した従来のものの特性が $0.57\text{V} \sim 0.58\text{V}$ 、 $35\text{mA} \sim 37\text{mA}$ であったのに対し、この実施例に係るBSF型太陽電池の特性は $0.59\text{V} \sim 0.60\text{V}$ 、 $37\text{mA} \sim 39\text{mA}$ であった。

【0050】[実施例2] p型ポリシリコン層2とn⁺ポリシリコン層5に代えてp型アモルファスシリコン層とn⁺アモルファスシリコン層を適用し、かつ、その製膜条件が下記である点を除き実施例1と略同一である。

【0051】そして、この実施例に係るBSF型太陽電池においてもその特性が $0.59\text{V} \sim 0.60\text{V}$ 、 $37\text{mA} \sim 39\text{mA}$ であり従来例に較べて良好であった。

【0052】(p型アモルファスシリコン層2の製膜条件)

原料ガスの種類と組成: $B_2H_6/SiH_4/SiF_4/H_2 = 0.1/10/100/400$

原料ガスの供給速度: $5\text{ sccm} \sim 100\text{ sccm}$

原料ガスの圧力: $50\text{ mtorr} \sim 1\text{ torr}$

n⁻単結晶シリコン基板の加熱温度: 600°C

(n⁺アモルファスシリコン層5の製膜条件)

原料ガスの種類と組成: $PH_3/SiH_4/SiF_4/H_2 = 0.1/10/100/400$

原料ガスの供給速度: $5\text{ sccm} \sim 100\text{ sccm}$

原料ガスの圧力: $50\text{ mtorr} \sim 1\text{ torr}$

n⁻単結晶シリコン基板の加熱温度: 600°C

[実施例3] p型アモルファスシリコン層2とn⁺アモ

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ルファスシリコン層5の製膜条件が下記である点を除き実施例2と略同一である。

【0053】そして、この実施例に係るBSF型太陽電池においてもその特性が $0.58\text{V} \sim 0.59\text{V}$ 、 $36\text{mA} \sim 38\text{mA}$ であり従来例に較べて良好であった。

【0054】(p型アモルファスシリコン層2の製膜条件)

原料ガスの種類と組成: $In(CH_3)_3/SiH_4/SiH_2F_2/\text{アルゴン} = 0.1/10/100/400$

10 原料ガスの供給速度: $5\text{ sccm} \sim 100\text{ sccm}$

原料ガスの圧力: $50\text{ mtorr} \sim 1\text{ torr}$

n⁻単結晶シリコン基板の加熱温度: 650°C

(n⁺アモルファスシリコン層5の製膜条件)

原料ガスの種類と組成: $SbCl_3/SiH_4/SiH_2F_2/\text{アルゴン} = 0.1/10/100/400$

原料ガスの供給速度: $5\text{ sccm} \sim 100\text{ sccm}$

原料ガスの圧力: $50\text{ mtorr} \sim 1\text{ torr}$

n⁻単結晶シリコン基板の加熱温度: 650°C

20 [実施例4] p型アモルファスシリコン層2とn⁺アモルファスシリコン層5の製膜条件が下記である点を除き実施例2と略同一である。

【0055】そして、この実施例に係るBSF型太陽電池においてもその特性が $0.58\text{V} \sim 0.59\text{V}$ 、 $36\text{mA} \sim 38\text{mA}$ であり従来例に較べて良好であった。

【0056】(p型アモルファスシリコン層2の製膜条件)

原料ガスの種類と組成: $Al(CH_3)_3/SiH_4/SiH_2F_2/H_2/\text{アルゴン} = 0.1/10/100/300/100$

30 原料ガスの供給速度: $5\text{ sccm} \sim 100\text{ sccm}$

原料ガスの圧力: $50\text{ mtorr} \sim 1\text{ torr}$

n⁻単結晶シリコン基板の加熱温度: 700°C

(n⁺アモルファスシリコン層5の製膜条件)

原料ガスの種類と組成: $PH_3/SiH_4/SiH_2F_2/H_2/\text{アルゴン} = 0.1/10/100/300/100$

原料ガスの供給速度: $5\text{ sccm} \sim 100\text{ sccm}$

原料ガスの圧力: $50\text{ mtorr} \sim 1\text{ torr}$

n⁻単結晶シリコン基板の加熱温度: 700°C

40 [実施例5] 図3に示された装置に代えて図4に示すように基板近傍の空間部位にタングステンの熱フィラメント20が配置された熱CVD装置を適用すると共に、上記p型ポリシリコン層2とn⁺ポリシリコン層5の製膜条件が下記である点を除き実施例1と略同一である。

【0057】そして、この実施例に係るBSF型太陽電池においてもその特性が $0.59\text{V} \sim 0.60\text{V}$ 、 $37\text{mA} \sim 39\text{mA}$ であり従来例に較べて良好であった。

【0058】(p型ポリシリコン層2の製膜条件)

原料ガスの種類と組成: $Ga(CH_3)_3/SiH_4/SiF_4/H_2 = 0.1/10/100/400$

原料ガスの供給速度: 5 sccm~100 sccm
 原料ガスの圧力: 50 mtorr~1 torr
 n⁻単結晶シリコン基板の加熱温度: 650℃
 (n⁺ポリシリコン層5の製膜条件)
 原料ガスの種類と組成: AsH₃/SiH₄/SiF₄/H₂=0.1/10/100/400
 原料ガスの供給速度: 5 sccm~100 sccm
 原料ガスの圧力: 50 mtorr~1 torr
 n⁻単結晶シリコン基板の加熱温度: 650℃
 [実施例6] 図4に示された熱CVD装置を適用した点
 と、p型ポリシリコン層2とn⁺ポリシリコン層5の製
 膜条件が下記である点を除き実施例1と略同一である。
 【0059】そして、この実施例に係るBSF型太陽電
 池においてもその特性が0.58V~0.59V、36
 mA~38mAであり従来例に較べて良好であった。
 【0060】(p型ポリシリコン層2の製膜条件)
 原料ガスの種類と組成: B₂H₆/SiH₄/SiH₂F₂
 /H₂/アルゴン=0.1/10/100/400/1
 00
 原料ガスの供給速度: 5 sccm~100 sccm
 原料ガスの圧力: 50 mtorr~1 torr
 n⁻単結晶シリコン基板の加熱温度: 650℃
 (n⁺ポリシリコン層5の製膜条件)
 原料ガスの種類と組成: PH₃/SiH₄/SiH₂F₂/
 H₂/アルゴン=0.1/10/100/400/10
 0
 原料ガスの供給速度: 5 sccm~100 sccm
 原料ガスの圧力: 50 mtorr~1 torr
 n⁻単結晶シリコン基板の加熱温度: 650℃
 [実施例7] 図5に示された光CVD装置を適用した点
 と、p型アモルファスシリコン層2とn⁺アモルファス
 シリコン層5の製膜条件が下記である点を除き実施例2
 と略同一である。
 【0061】そして、この実施例に係るBSF型太陽電
 池においてもその特性が0.59V~0.60V、37
 mA~39mAであり従来例に較べて良好であった。
 【0062】(p型アモルファスシリコン層2の製膜条
 件)
 製膜室内の圧力: 1~10 mTorr
 原料ガスの種類と組成: B₂H₆/SiH₄/H₂=0.1
 /10/300
 原料ガスの供給速度: 5 sccm~100 sccm
 原料ガスの圧力: 50 mtorr~1 torr
 紫外光の照射光源: Hgランプ
 n⁻単結晶シリコン基板の加熱温度: 600℃
 (n⁺アモルファスシリコン層5の製膜条件)
 製膜室内の圧力: 1~10 mTorr
 原料ガスの種類と組成: PH₃/SiH₄/H₂=0.1
 /10/300
 原料ガスの供給速度: 5 sccm~100 sccm

原料ガスの圧力: 50 mtorr~1 torr
 紫外光の照射光源: Hgランプ
 n⁻単結晶シリコン基板の加熱温度: 600℃
 [実施例8] 図6に示されたイオンプレーティング装置
 を適用し、かつ、このイオンプレーティング装置内にS
 iF₄ ガスを供給した点と、p型ポリシリコン層2とn
⁺ポリシリコン層5の製膜条件が下記である点を除き実
 施例1と略同一である。
 【0063】そして、この実施例に係るBSF型太陽電
 池においてもその特性が0.58V~0.59V、36
 mA~38mAであり従来例に較べて良好であった。
 【0064】(p型ポリシリコン層2の製膜条件)
 製膜室内の圧力: 1~10 mTorr
 ターゲット: B₂H₆がドーパされたSi
 RFコイルへの投入電力: 50~200W
 n⁻単結晶シリコン基板の加熱温度: 700℃
 (n⁺ポリシリコン層5の製膜条件)
 製膜室内の圧力: 1~10 mTorr
 ターゲット: PH₃がドーパされたSi
 RFコイルへの投入電力: 50~200W
 n⁻単結晶シリコン基板の加熱温度: 700℃
 【0065】
 【発明の効果】請求項1~2に係る発明によれば、ハロ
 ゲン原子を放出するSiF₄ ガスあるいはフッ素化シラ
 ンガスを適用しているにも拘らず製膜室内における浮遊
 異物の発生を確実に防止でき、かつ熱CVD法を適用し
 ているにも拘らず基板加熱温度の低減を図ることが可能
 となる。
 【0066】また、請求項3に係る発明によれば、製膜
 室内に配置されたn型又はp型シリコン基板近傍の空間
 部位に設けられた発熱部材の作用により製膜ガスの熱分
 解が著しく促進されるため、フッ素系ラジカルのエッチ
 ング作用と相乗して基板加熱温度を更に低減させること
 が可能となる。
 【0067】従って、低温製膜条件で膜質良好なn⁺又
 はp⁺シリコン層をn型又はp型シリコン基板上に形成
 することが可能になるため、光電変換効率の高いBSF
 型太陽電池を安定して製造できる効果を有している。
 【0068】次に、請求項4に係る発明によれば、加熱
 されたシリコン基板面に上記n⁺又はp⁺シリコン層を光
 CVD法により製膜し、また、請求項5に係る発明によ
 れば、フッ素化シランガス又はSiF₄ ガスが存在する
 条件下においてイオンプレーティング法により加熱され
 たシリコン基板面に上記n⁺又はp⁺シリコン層を製膜し
 ているため、請求項1~3に係る発明と同様、低温製膜
 条件で膜質良好なn⁺又はp⁺シリコン層をn型又はp型
 シリコン基板上に形成することが可能となり、光電変換
 効率の高いBSF型太陽電池を安定して製造できる効果
 を有している。
 【図面の簡単な説明】

【図1】実施例に係るBSF型太陽電池の断面図。

【図2】図2(A)～(B)はBSF型太陽電池の製造工程図。

【図3】実施例1において適用された熱CVD装置の説明図。

【図4】実施例5において適用された熱CVD装置の説明図。

【図5】実施例7において適用された光CVD装置の説明図。

【図6】実施例8において適用されたイオンブレーティ

ング装置の説明図。

【図7】従来の太陽電池の斜視図。

【図8】従来の太陽電池の断面図。

【図9】従来の太陽電池の構造をモデル的に記載した構造概念図。

【図10】従来の太陽電池のエネルギーバンド図。

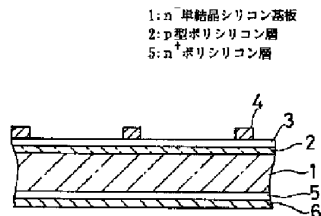
【符号の説明】

1 n⁻単結晶シリコン基板

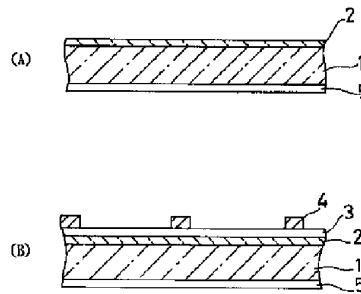
2 p型ポリシリコン層

5 n⁺ポリシリコン層

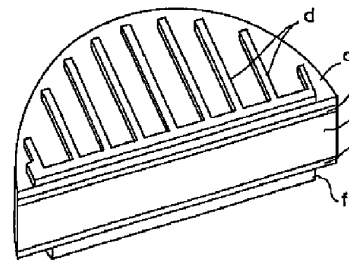
【図1】



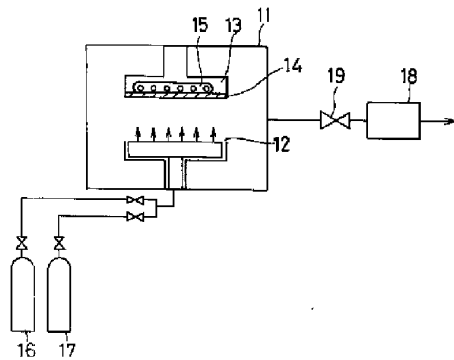
【図2】



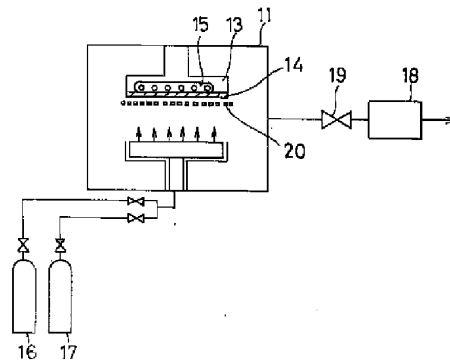
【図7】



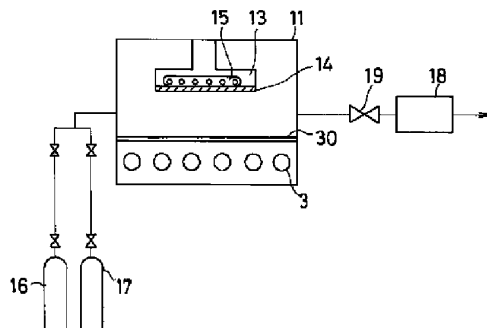
【図3】



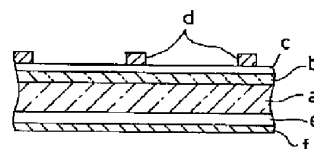
【図4】



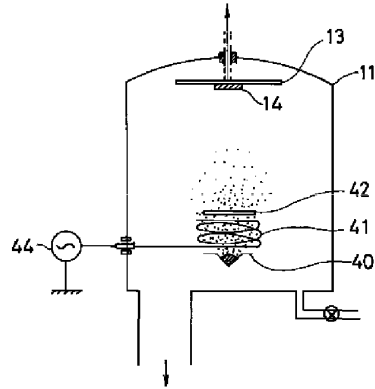
【図5】



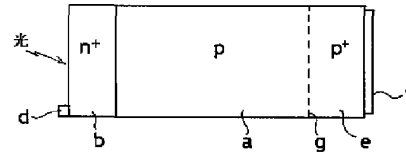
【図8】



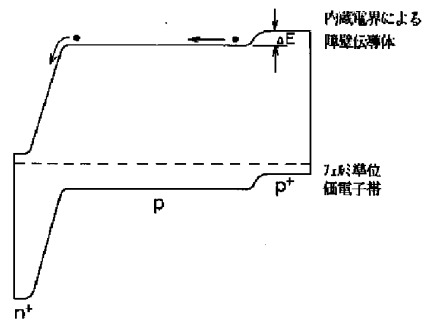
【図6】



【図9】



【図10】



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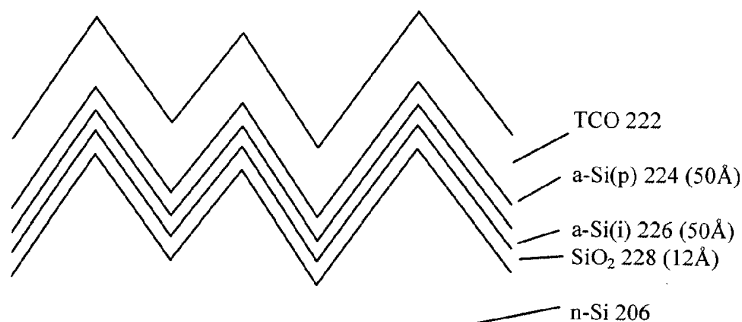


FIG. 2A

(57) **Abstract:** The present invention relates to improved HIT type or polysilicon emitter solar cells. According to certain aspects, the invention includes forming a masking oxide layer on the front and back of the cell and then patterning holes in the masking oxide. A HIT cell structure or polysilicon emitter solar cell structure is then formed over the patterned oxide, creating the cell junction only in the areas where holes have been cut. Benefits of the invention include that it provides a controlled interface for the HIT cell through insertion of a thin tunnel oxide. Moreover, the tunnel oxide prevents epitaxial growth of amorphous silicon, allowing it to remain amorphous for the optimum band structure. Still further, it provides a layer to protect the surface from plasma damage during deposition of the a-Si layer. Further, it may be used in conjunction with a point contact structure to further increase efficiency.

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IMPROVED HIT SOLAR CELL STRUCTURE

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] The present application claims priority to U.S. Prov. Appln. No. 61/023,342 filed January 24, 2008, the contents of which are incorporated herein by reference in their entirety.

FIELD OF THE INVENTION

[0002] The present invention relates to photovoltaic devices, and more particularly to methods and apparatuses for providing an improved structure of a HIT type or polysilicon emitter type solar cells.

BACKGROUND

[0003] HIT type solar cells are high efficiency devices with relatively simple structures. Sanyo Corporation of Japan has reported lab efficiencies of 21.5% and manufacturing efficiency in the mid-19% range. Many other groups have worked on this device, although none has shown as high efficiencies.

[0004] A typical HIT type solar cell structure is shown in FIG. 1A and 1B. The device is symmetric, with the front and back of the n-type substrate 106 both coated with a coating 102 and 110, respectively and metal grid lines 104 and 108, respectively. As shown in the blowup portion of FIG. 1B, the coating 102 on the front consists of two amorphous silicon layers, an intrinsic layer 126 under a p-type layer 124, both about 50 Angstroms thick. On the back, the amorphous silicon layer consists of an intrinsic (i) layer under an n-type layer. As further shown in FIG. 1B, the coating 102 further includes a layer of transparent conductive oxide (TCO) 122.

[0005] The purpose of the thin a-Si layers is to both passivate the surface and to provide a heterojunction with a wide bandgap window layer to improve the open circuit voltage, as shown in FIG. 1C. More particularly, FIG. 1C illustrates the band structure of such a device. As shown in FIG. 1C, there is a large potential step at the front surface, creating a junction much like a junction found at the step between p- and n-type dopants. However, because this junction is formed by depositing a layer of amorphous silicon, it is very abrupt, and nearly ideal.

[0006] Despite their benefits, these amorphous silicon layers also introduce considerable complexity into the fabrication of the HIT cell. For example, the layers must be formed on a carefully prepared surface, whose preparation details have not been published. Further, they must not crystallize, as can happen when the amorphous silicon is seeded by the crystal silicon substrate, as this will eliminate the beneficial passivation and heterojunction effects.

[0007] Therefore, there is a lingering need for an improved interface that is well controlled and understood and easy to manufacture, and does not seed crystal growth.

SUMMARY

[0008] The present invention relates to improved HIT type or polysilicon emitter solar cells. According to certain aspects, the invention includes forming a masking oxide layer on the front and back of the cell and then patterning holes in the masking oxide. A HIT cell structure or polysilicon emitter solar cell structure is then formed over the patterned oxide, creating the cell junction only in the areas where holes have been cut. Benefits of the invention include that it provides a controlled interface for the HIT cell through insertion of a thin tunnel oxide. Moreover, the tunnel oxide prevents epitaxial growth of amorphous silicon, allowing it to remain amorphous for the optimum band structure. Still further, it provides a layer to protect the surface

from plasma damage during deposition of the a-Si layer. Further, it may be used in conjunction with a point contact structure to further increase efficiency.

[0009] In furtherance of these and other aspects, a solar cell according to embodiments of the invention comprises an amorphous semiconductor layer formed over a substrate; and a dielectric layer interposed between the substrate and the amorphous semiconductor layer, wherein the dielectric layer is sufficiently thin so as to support a tunneling current therethrough.

[0010] In additional furtherance of these and other aspects, a method of fabricating a solar cell according to embodiments of the invention includes forming a dielectric layer on a substrate, wherein the dielectric layer is sufficiently thin so as to support a tunneling current therethrough; and forming an amorphous semiconductor layer formed over the dielectric layer.

BRIEF DESCRIPTION OF THE DRAWINGS

[0011] These and other aspects and features of the present invention will become apparent to those ordinarily skilled in the art upon review of the following description of specific embodiments of the invention in conjunction with the accompanying figures, wherein:

[0012] FIGs. 1A to 1C show a conventional HIT cell and its band structure.

[0013] FIGs. 2A and 2B show an example solar structure of the present invention and its band structure, respectively.

[0014] FIG. 3 is a diagram illustrating an example process flow to form the structure of FIG. 2 according to aspects of the invention.

DETAILED DESCRIPTION

[0015] The present invention will now be described in detail with reference to the drawings, which are provided as illustrative examples of the invention so as to enable those

skilled in the art to practice the invention. Notably, the figures and examples below are not meant to limit the scope of the present invention to a single embodiment, but other embodiments are possible by way of interchange of some or all of the described or illustrated elements. Moreover, where certain elements of the present invention can be partially or fully implemented using known components, only those portions of such known components that are necessary for an understanding of the present invention will be described, and detailed descriptions of other portions of such known components will be omitted so as not to obscure the invention. In the present specification, an embodiment showing a singular component should not be considered limiting; rather, the invention is intended to encompass other embodiments including a plurality of the same component, and vice-versa, unless explicitly stated otherwise herein. Moreover, applicants do not intend for any term in the specification or claims to be ascribed an uncommon or special meaning unless explicitly set forth as such. Further, the present invention encompasses present and future known equivalents to the known components referred to herein by way of illustration.

[0016] In general, the present inventors recognize that thin tunnel oxide layers can be used in solar cells. For example, some MIS cells can be made using aluminum over tunnel oxides. The present inventors further recognize that tunnel oxides can be used between a heavily doped or insulating layer of polysilicon and a crystal silicon substrate, forming a polysilicon emitter solar cell. Such a solar cell has a similar band structure to a HIT cell, essentially replacing the TCO and a-Si layers with polysilicon. However, such cells do not provide the heterojunction and its benefit of a higher cell voltage due to the higher bandgap of a-Si.

[0017] An example solar cell structure according to embodiments of the invention and the associated band structure is shown in FIGs. 2A and 2B, respectively.

[0018] As shown in FIG. 2A, which can be part of a front surface of a HIT-type solar cell similar to that shown in FIG. 1, a thin dielectric layer 228 (e.g. tunnel oxide) is provided between the a-Si layers 224 and 226 and the n-type substrate 206 in a HIT cell. The dielectric layer is preferably thin, on the order of 8-15Å, in order to support a tunneling current between the substrate and a-Si layers. As will be described in more detail below, layer 228 can be formed using conventional methods such as rapid thermal oxidation, furnace oxidation, or the Chemox process (formation in an ozonated H₂O₂ bath). In some cases, the layer may be nitrided or formed using other materials such as silicon nitride or silicon oxynitride.

[0019] As shown in FIG. 2B, added dielectric layer at the interface provides a bandgap much larger than the bandgap of the semiconductors. Carriers cannot get over the energy barrier, but tunnel through if the layer is sufficiently thin (<15Å). Note that oxide and nitride will have different barrier heights, so the layer shown is not meant to represent any one material. The barrier height for nitride is about 2.5 eV and is symmetric. The barrier height for oxide is asymmetric (lower for electrons).

[0020] The benefits provided by dielectric layer 228 are several-fold. For example, it may be formed using conventional surface cleaning and preparation methods, as are used to make MOS gates for ICs. Therefore, the surface preparation is well known and understood, and routinely implemented in high volume manufacturing. Moreover, as it is an amorphous layer, it separates the subsequent a-Si layer from the substrate, preventing epitaxial seeding of crystal

growth in the a-Si layer. Further, it provides an intervening layer to protect the crystal silicon surface from plasma damage during deposition of the a-Si layer.

[0021] It should be noted that, although benefits of the invention are obtained with a-Si layers formed over a crystalline silicon substrate, that this is not limiting, and that the invention can be applied to other types of substrates and thin semiconductor layers. It should be further noted that many solar cells use heterojunctions. So, for example, the invention could be used with a thin film solar cell with amorphous silicon on micro-crystal silicon. It could also be used on CdTe, CIGS or AlGaAs/GaAs cells, all of which use heterojunctions.

[0022] That said, it should be still further noted that amorphous silicon on silicon is known to provide excellent passivation properties, nearly eliminating surface recombination. This is because the high band bending at the surface repels carriers. Accordingly, this is one advantage of using amorphous silicon on silicon.

[0023] FIG. 3 is a diagram illustrating an example process flow used to make the structure of FIG. 2A. First, in step S302, the front surface of the n-type substrate is textured. This may be accomplished using conventional etching, such as isopropyl alcohol and KOH. Next in step S304, the surface is provided with a standard MOS clean to remove native oxides, ionic contamination, and organics.

[0024] In one embodiment, a rapid thermal oxide process is then used in step S306 to form a thin tunnel oxide, typically 12Å thick, on the front surface. In another embodiment of the invention, the oxide is formed on both front and back at the same time. Next the a-Si layers are deposited on the front surface. In one embodiment, the a-Si is formed as a two layer stack on the front surface, with an intrinsic a-Si, 20-50 Å thick formed first in step S308, for example by

plasma enhanced chemical vapor deposition (PE-CVD), which is the decomposition of silane in a plasma, often with hydrogen present. These processes are well known in the literature. Boron may be added to provide p-type doping, and phosphorous may be added to provide n-type doping. Next, a p-type a-Si, 20-50 Å thick is formed on top of the intrinsic a-Si layer in step S312, for example by the same PE-CVD process. In another embodiment, only a doped p-type layer is formed on the front surface in step S310, without the i-type layer. The TCO is deposited in step S314, which may be a quarter wave thick layer of indium tin oxide.

[0025] The wafer is then flipped over in step S316, and the structure is deposited in the same manner on the back side, now using n-type a-Si instead of p-type. As shown, depending on whether the oxide layer has already been formed, processing returns to step S306 or step S308. It should be further apparent that processing could also return to step S310 if the oxide layer has already been formed. Finally, contacts are formed in step S318, for example by screen printing or sputtering.

[0026] Additionally or alternatively to the process described above, a method to form point contacts for HIT or polysilicon emitter solar cells, as described in co-pending application No. ____ (AMAT-12964), the contents of which are incorporated herein by reference in their entirety, may be performed.

[0027] Although the present invention has been particularly described with reference to the preferred embodiments thereof, it should be readily apparent to those of ordinary skill in the art that changes and modifications in the form and details may be made without departing from the spirit and scope of the invention. It is intended that the appended claims encompass such changes and modifications.

WHAT IS CLAIMED IS:

1. A solar cell comprising:
 - an amorphous semiconductor layer formed over a substrate;
 - a dielectric layer interposed between the substrate and the amorphous semiconductor layer, wherein the dielectric layer is sufficiently thin so as to support a tunneling current therethrough.
2. A solar cell according to claim 1, wherein the substrate comprises silicon and the dielectric layer comprises silicon dioxide.
3. A solar cell according to claim 1, wherein the substrate comprises silicon and the dielectric layer comprises nitrogen.
4. A solar cell according to claim 1, wherein the amorphous semiconductor layer comprises silicon.
5. A solar cell according to claim 1, wherein the amorphous semiconductor layer comprises a two-layer stack of an intrinsic amorphous silicon layer and a doped amorphous silicon layer.
6. A solar cell according to claim 1, wherein the amorphous semiconductor layer is formed on a front surface of the substrate, wherein the solar cell further comprises:

another amorphous semiconductor layer is formed on an opposite back surface of the substrate; and

another dielectric layer interposed between the substrate and the another amorphous semiconductor layer, wherein the another dielectric layer is sufficiently thin so as to support a tunneling current therethrough.

7. A solar cell according to claim 6, wherein both the amorphous semiconductor layer and the another amorphous semiconductor layer comprise a two-layer stack of an intrinsic amorphous silicon layer and a doped amorphous silicon layer.

8. A method of fabricating a solar cell, comprising:

forming a dielectric layer on a substrate, wherein the dielectric layer is sufficiently thin so as to support a tunneling current therethrough; and

forming an amorphous semiconductor layer formed over the dielectric layer.

9. A method according to claim 8, wherein the step of forming the amorphous semiconductor layer includes forming a two-layer stack of an intrinsic amorphous silicon layer and a doped amorphous silicon layer.

10. A method according to claim 8, further comprising:

texturing a surface of the substrate before forming the dielectric layer.

11. A method according to claim 8, wherein a rapid thermal oxide process is used to form the dielectric layer.
12. A method according to claim 9, wherein the intrinsic and doped amorphous silicon layers are both about 20-50 Å thick.
13. A method according to claim 8, further comprising depositing a layer of TCO over the amorphous semiconductor layer.
14. A method according to claim 13, wherein the TCO comprises a quarter wave thick layer of indium tin oxide.
15. A method according to claim 8, wherein the amorphous semiconductor layer is formed on a front surface of the substrate, wherein the method further comprises:
- forming another dielectric layer on an opposite back surface of the substrate, wherein the another dielectric layer is sufficiently thin so as to support a tunneling current therethrough; and
 - forming another amorphous semiconductor layer over the another dielectric layer.

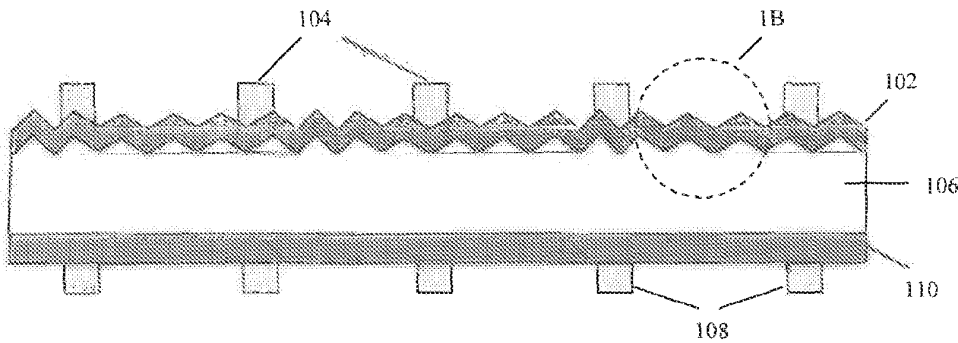


FIG. 1A

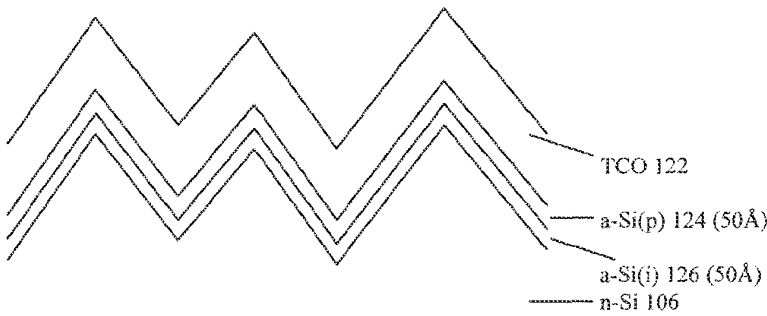


FIG. 1B

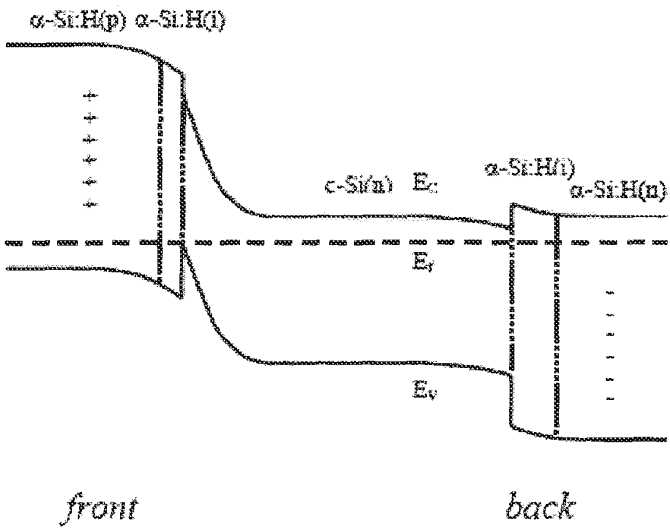


FIG 1C

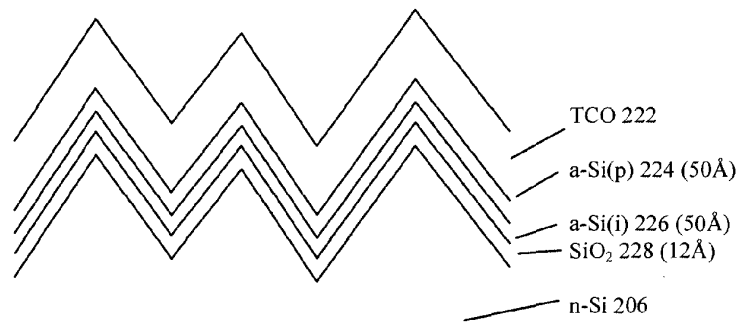


FIG. 2A

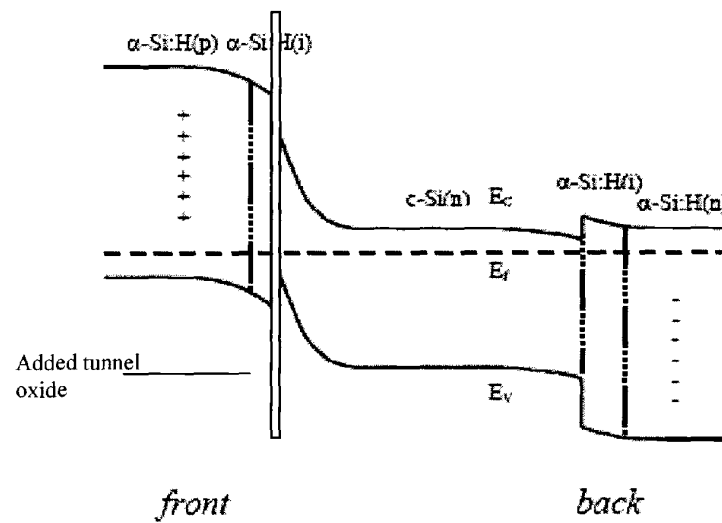
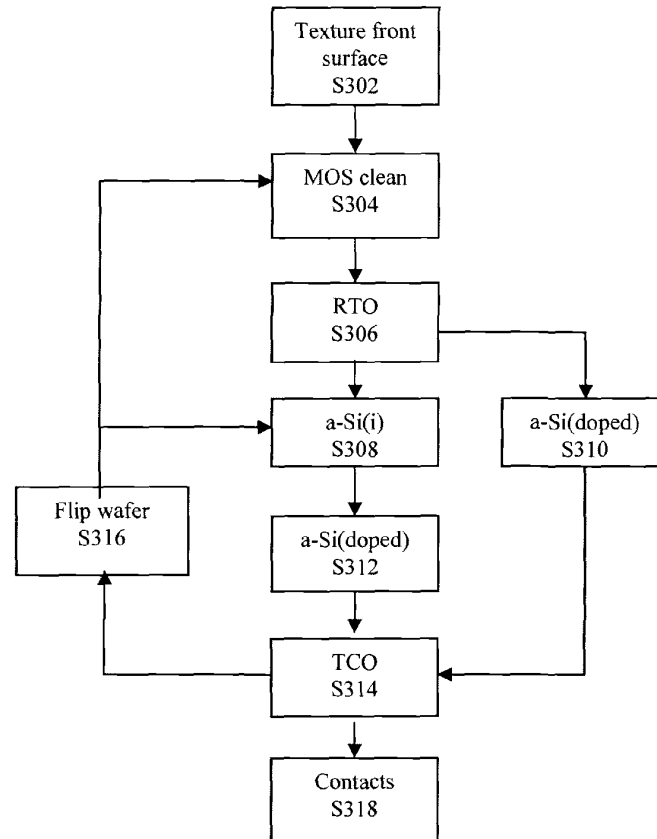


FIG. 2B

**FIG. 3**

EAST Search History

EAST Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
S1	2	"20030134469"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2009/12/07 08:43
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S4	1	"10/353261"	USPAT	OR	ON	2009/12/07 08:57
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S10	65	texture and antireflective and emitter	US-PGPUB; USPAT; USOCR	OR	ON	2009/12/07 09:09
S9	10	(back near surface near field) and texture and antireflective and emitter	US-PGPUB; USPAT; USOCR	OR	ON	2009/12/07 09:09
S11	66	texture and antireflective and emitter	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2009/12/07 09:10
S13	54	S12 not S11	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2009/12/07 09:11
S12	120	textur\$4 and antireflective and emitter	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2009/12/07 09:11
S14	18	S13 and dielectric	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2009/12/07 09:12
S16	443	dielectric and antireflective and emitter	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2009/12/07 09:17

S15	3	"20070082206"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2009/12/07 09:17
S18	192	(back near surface near field) and dielectric	US-PGPUB; USPAT; USOCR	OR	ON	2009/12/07 09:18
S17	132	dielectric and antireflective and emitter and ((solar near cell) (photovoltaic))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2009/12/07 09:18
S19	1	"20030134469"	US-PGPUB; USPAT; USOCR	OR	ON	2009/12/07 09:28
S20	19	("3413157" "4012235" "4239810" "4313768" "4604791" "4624045" "4633031" "4781766" "4836861" "4910153" "5879977" "6111191").PN. OR ("6210991").URPN.	US-PGPUB; USPAT; USOCR	OR	ON	2009/12/07 09:51
S21	2	"20060196535"	US-PGPUB; USPAT; USOCR	OR	ON	2009/12/07 09:55
S22	14	("20030070707" "4070097" "4084099" "4278831" "4496788" "5057439" "5066340" "5213628" "5468652" "5728230" "6013582" "6118258" "6210991" "6465724").PN. OR ("7554031").URPN.	US-PGPUB; USPAT; USOCR	OR	ON	2009/12/07 10:13
S25	124	S23 and ((solar near cell) (photovoltaic))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2009/12/07 10:17

S24	347	dielectric and (antireflection or anti near reflection or ARC) and emitter and textur\$5	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2009/12/07 10:17
S23	346	dielectric and (antireflection or anti near reflection or ARC) and emitter and textur\$5	US-PGPUB; USPAT; USOCR	OR	ON	2009/12/07 10:17
S26	7	11/263159	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2009/12/07 10:50
S27	29	S24 and optoelectronic	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2009/12/07 11:08
S30	32	S29 and ((solar near cell) (photovoltaic))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2009/12/07 11:09
S29	133	S28 not S24	US-PGPUB; USPAT; USOCR	OR	ON	2009/12/07 11:09
S28	479	dielectric and (antireflection or anti near reflection or ARC) and (emitter or collector) and textur\$5	US-PGPUB; USPAT; USOCR	OR	ON	2009/12/07 11:09
S31	19	("4090213" "4131486" "4133698" "4232245" "4255211" "4315097" "4316049" "4341918" "4365262"	US-PGPUB; USPAT; USOCR	OR	ON	2009/12/07 11:32

		"4367368" "4385198" "4427839").PN. OR ("4665277").URPN.				
S32	14	("3150999" "4227942" "4348254").PN. OR ("4427839").URPN.	US-PGPUB; USPAT; USOCR	OR	ON	2009/12/07 11:35
S35	215	S34 not (S17)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2009/12/07 11:47
S34	233	S33 and (solar near cell)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2009/12/07 11:47
S33	1092	(antireflection or anti near reflection or ARC) and emitter and textur\$5	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2009/12/07 11:47
S36	215	S35 not S29	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2009/12/07 11:48
S38	2	"20040112426"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2009/12/07 12:08

S37	0	2004/0112426	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2009/12/07 12:08
S39	10	("20040200520" "4234352" "4478879" "4920639" "4927770" "5053083" "5320684" "5538564" "5641362" "6624737").PN. OR ("7339110").URPN.	US-PGPUB; USPAT; USOCR	OR	ON	2009/12/07 12:14
S40	88	(back near surface near field) and antireflective and emitter	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2009/12/07 12:23
S43	138	S41 not S36	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2009/12/07 12:24
S42	87	S41 not S40	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2009/12/07 12:24
S41	175	(back near surface near field) and (antireflective ARC (anti near reflective)) and emitter	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2009/12/07 12:24

S44	26	("2841860" "2854363" "3134906" "4070689" "4341589" "4428783" "4523966" "4665277" "4703553" "5156978").PN. OR ("5928438").URPN.	US-PGPUB; USPAT; USOCR	OR	ON	2009/12/07 12:30
S45	19	("4090213" "4131486" "4133698" "4232245" "4255211" "4315097" "4316049" "4341918" "4365262" "4367368" "4385198" "4427839").PN. OR ("4665277").URPN.	US-PGPUB; USPAT; USOCR	OR	ON	2009/12/07 13:00
S46	11	("3081370" "3757123" "3948682" "3969746").PN. OR ("4131486").URPN.	US-PGPUB; USPAT; USOCR	OR	ON	2009/12/07 13:02
S47	15	"5258077"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2009/12/07 14:11
S48	14	("3895975" "4056879" "4106047" "4131486" "4226017" "4916503" "5538564" "5641362" "5951742" "5973260" "6071753").PN. OR ("6262359").URPN.	US-PGPUB; USPAT; USOCR	OR	ON	2009/12/07 14:13
S49	7	(back near junction) and (passiv\$4 with "SiO.sub.2")	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2009/12/07 15:25
S50	10	(back with surface with field) and (passiv\$4 with "SiO.sub.2")	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2009/12/07 15:27
S51	15	(passiv\$4 with "SiO.sub.2" with emitter)	US-PGPUB; USPAT; USOCR; FPRS; EPO;	OR	ON	2009/12/07 15:28

			JPO; DERWENT; IBM_TDB			
S53	67	(passiv\$4 with ("SiO.sub.2" or (silicon near dioxide))) and solar near cell	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2009/12/07 15:31
S52	1984	(passiv\$4 with ("SiO.sub.2" or (silicon near dioxide)))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2009/12/07 15:31
S54	3	"20070082206"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2009/12/07 15:37
S55	14	("3895975" "4056879" "4106047" "4131486" "4226017" "4916503" "5538564" "5641362" "5951742" "5973260" "6071753").PN. OR ("6262359").URPN.	US-PGPUB; USPAT; USOCR	OR	ON	2009/12/07 16:00
S56	163	(back near junction) and (solar near cell)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2009/12/07 16:13
S58	39	S57 not S56	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO;	OR	ON	2009/12/07 16:29

			DERWENT; IBM_TDB			
S57	141	(back near junction) and (photovoltaic)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2009/12/07 16:29
S61	32	S60 and emitter	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2009/12/07 16:31
S60	182	S59 not S56	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2009/12/07 16:31
S59	345	(back near2 junction) and (solar near cell or (photovoltaic))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2009/12/07 16:31
S62	16	(US-20050268963-\$ or US- 20020153039-\$ or US-20060196535-\$ or US-20090101199-\$ or US-20040097062- \$ or US-20040112426-\$ or US- 20070186970-\$).did. or (US-4379944-\$ or US-4665277-\$ or US-5320684-\$ or US-6210991-\$ or US-5792280-\$ or US- 5899704-\$ or US-6262359-\$ or US- 5258077-\$).did. or (US-20090205712- \$).did.	US-PGPUB; USPAT; DERWENT	OR	ON	2009/12/07 16:33

S65	16	S64 and (isolation near trench)	US-PGPUB; USPAT; USOCR	OR	ON	2009/12/07 16:34
S64	346	dielectric and (antireflection or anti near reflection or ARC) and emitter and textur\$5	US-PGPUB; USPAT; USOCR	OR	ON	2009/12/07 16:34
S63	0	S62 and (isolation near2 trench)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2009/12/07 16:34
S66	251	solar near cell and (isolation near trench)	US-PGPUB; USPAT; USOCR	OR	ON	2009/12/07 16:35
S68	2	S67 and solar near cell	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2009/12/07 16:36
S67	232	(back with surface with field) and (isolation near trench)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2009/12/07 16:36
S69	24	(back with surface with field) and (isolation near2 edge) and (solar near cell)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2009/12/07 16:40
S70	49	("20030134469" "20040200520" "20040200520" "20060130891" "20070082206" "3961997" "3961997" "4927770" "4927770" "5030295" "5053083" "5057439" "5164019"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO;	OR	ON	2009/12/07 16:54

		"5217539" "5360990" "5369291" "5641362" "5030295" "5053083" "5057439" "5164019" "5217539" "5266125" "5360990" "5369291" "5641362" "6274402" "6313395" "6333457" "6387726" "6423568" "6998288" "6998288" "6274402" "6313395" "6333457" "6337283" "6387726" "6423568" "6524880" "6998288" "7135350" "7135350").PN.	DERWENT; IBM_TDB			
S72	32	S71 and ((solar near cell) photovoltaic)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2009/12/07 17:00
S71	288	oxide with passiv\$5 with emitter	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2009/12/07 17:00
S73	29	"4726850"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2009/12/07 17:29
S75	32	(back with surface with field) and (isolat\$3 near5 edge) and (solar near cell)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2009/12/07 17:34
S74	0	(back with surface with field) and (isolat\$3 near5 edge with trench) and (solar near cell)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO;	OR	ON	2009/12/07 17:34

			DERWENT; IBM_TDB			
S76	39	(back with surface with field) and (isolation near5 trench with etch)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2009/12/07 17:40
S77	20	(solar near cell) and (isolation near5 trench with etch)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2009/12/07 17:41
S79	7	(solar near cell) and (isolation near5 trench with edge)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2009/12/07 17:42
S78	304	(solar near cell) and (isolation near5 trench)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2009/12/07 17:42
S80	24	(trench with (electric\$4 near isolat\$4)) and emitter and (solar near cell)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2009/12/07 17:52
S81	41	(silver near5 ("SiO.sub.2" or silicon near dioxide)) and (solar near cell) and emitter	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO;	OR	ON	2009/12/07 18:06

			DERWENT; IBM_TDB			
S83	50	((silver or Ag) near5 ("SiO.sub.2" or silicon near dioxide or passiv\$4)) and (solar near cell) and emitter	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2009/12/07 18:07
S82	42	(silver near5 ("SiO.sub.2" or silicon near dioxide or passiv\$4)) and (solar near cell) and emitter	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2009/12/07 18:07
S84	44	((silver) near5 ("SiO.sub.2" or silicon near dioxide or passiv\$4)) and ((solar near cell) or photovoltaic) and emitter	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2009/12/07 18:08
S86	46	S85 not S84	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2009/12/07 18:09
S85	90	((silver) near5 ("SiO.sub.2" or silicon near dioxide or passiv\$4)) and ((solar near cell) or photovoltaic)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2009/12/07 18:09
S88	15	S87 not S85	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO;	OR	ON	2009/12/07 18:12

			DERWENT; IBM_TDB			
S87	105	((silver) near5 ("SiO.sub.2" or silicon near dioxide or passiv\$4)) and ((solar near cell) or photovoltaic or optoelectronic)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2009/12/07 18:12
S90	240	S89 not S87	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2009/12/07 18:13
S89	345	((silver) with ("SiO.sub.2" or silicon near dioxide or passiv\$4)) and ((solar near cell) or photovoltaic or optoelectronic)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2009/12/07 18:13
S91	14	("3150999" "4227942" "4348254").PN. OR ("4427839").URPN.	US-PGPUB; USPAT; USOCR	OR	ON	2009/12/07 18:17
S95	25	S94 and solar near cell	US-PGPUB; USPAT; USOCR	OR	ON	2009/12/07 18:38
S94	565	silver near5 infrared near5 reflect\$4	US-PGPUB; USPAT; USOCR	OR	ON	2009/12/07 18:38
S93	584	silver near5 infrared with reflect\$4	US-PGPUB; USPAT; USOCR	OR	ON	2009/12/07 18:38
S92	1122	silver with infrared with reflect\$4	US-PGPUB; USPAT; USOCR	OR	ON	2009/12/07 18:38

S96	29	S94 and photovoltaic	US-PGPUB; USPAT; USOCR	OR	ON	2009/12/07 18:41
S97	18	"5479018"	US-PGPUB; USPAT; USOCR	OR	ON	2009/12/07 18:56
S98	1822	dichroic near coating	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2009/12/08 07:20
S99	54	dichroic near coating and (powder)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2009/12/08 07:21
S100	296	(fluorescent near powder) and (light near5 film)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2009/12/08 07:22
S103	5	"6262359"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2009/12/10 07:08
S102	1	2000-587576.NRAN.	DERWENT	OR	ON	2009/12/10 07:08
S101	1	6262359B1	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO;	OR	ON	2009/12/10 07:08

			DERWENT; IBM_TDB			
S105	11	("3081370" "3757123" "3948682" "3969746").PN. OR ("4131486").URPN.	US-PGPUB; USPAT; USOCR	OR	ON	2009/12/10 07:09
S104	14	("3895975" "4056879" "4106047" "4131486" "4226017" "4916503" "5538564" "5641362" "5951742" "5973260" "6071753").PN. OR ("6262359").URPN.	US-PGPUB; USPAT; USOCR	OR	ON	2009/12/10 07:09
S108	19	("4090213" "4131486" "4133698" "4232245" "4255211" "4315097" "4316049" "4341918" "4365262" "4367368" "4385198" "4427839").PN. OR ("4665277").URPN.	US-PGPUB; USPAT; USOCR	OR	ON	2009/12/10 07:11
S107	14	("3150999" "4227942" "4348254").PN. OR ("4427839").URPN.	US-PGPUB; USPAT; USOCR	OR	ON	2009/12/10 07:11
S106	12	("4090213" "4131486" "4133698" "4232245" "4255211" "4315097" "4316049" "4341918" "4365262" "4367368" "4385198" "4427839").PN.	US-PGPUB; USPAT; USOCR	OR	ON	2009/12/10 07:11
S109	9	floating same emitter same solar same cell	US-PGPUB; USPAT; USOCR	OR	ON	2009/12/10 07:33
S110	19	("4090213" "4131486" "4133698" "4232245" "4255211" "4315097" "4316049" "4341918" "4365262" "4367368" "4385198" "4427839").PN. OR ("4665277").URPN.	US-PGPUB; USPAT; USOCR	OR	ON	2009/12/10 07:35
S113	4	S112 and polycrystal\$4	US-PGPUB; USPAT; USOCR	OR	ON	2010/05/20 07:23
S112	16	("3895975" "4056879" "4106047" "4131486" "4226017" "4916503" "5538564" "5641362" "5951742" "5973260" "6071753").PN. OR ("6262359").URPN.	US-PGPUB; USPAT; USOCR	OR	ON	2010/05/20 07:23

S111	7	"6262359"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/05/20 07:23
S114	9	("4377901" "4478879" "5082791" "5665175").PN. OR ("6071753").URPN.	US-PGPUB; USPAT; USOCR	OR	ON	2010/05/20 07:26
S115	10	("20020011590" "5103851" "5437734" "5738732" "6071753" "6130380" "6166320" "6548751").PN. OR ("6927417").URPN.	US-PGPUB; USPAT; USOCR	OR	ON	2010/05/20 07:28
S116	6	("4837607" "5543333" "5738732").PN. OR ("6130380").URPN.	US-PGPUB; USPAT; USOCR	OR	ON	2010/05/20 07:29
S118	45	S117 and ((solar photovoltaic) near (battery device cell))	US-PGPUB; USPAT; USOCR	OR	ON	2010/05/20 07:43
S117	414	polycrystalline near5 substrate same emitter	US-PGPUB; USPAT; USOCR	OR	ON	2010/05/20 07:43
S119	10	"4665277"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/05/20 08:39
S120	1	"12070742"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/05/20 08:44
S121	1	"12070742"	US-PGPUB; USPAT; USOCR; FPRS; EPO;	OR	ON	2012/03/15 13:12

			JPO; DERWENT; IBM_TDB			
S122	41	polysilicon near2 emitter and (photovoltaic solar near2 (Cell device battery))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2012/03/15 13:28
S123	18	"4989059"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2012/03/15 13:34
S125	9	S124 not S122	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2012/03/15 13:35
S124	50	(polysilicon polycrystalline) near2 emitter and (photovoltaic solar near2 (Cell device battery))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2012/03/15 13:35
S129	128	(polysilicon polycrystalline) with emitter and (photovoltaic solar near2 (Cell device battery)) and (dielectric oxide)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2012/03/15 13:37
S128	347591	(polysilicon polycrystalline) wiith emitter and (photovoltaic solar near2 (Cell device battery)) and (dielectric oxide)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO;	OR	OFF	2012/03/15 13:37

			DERWENT; IBM_TDB			
S127	297	(polysilicon polycrystalline) same emitter and (photovoltaic solar near2 (Cell device battery)) and (dielectric oxide)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2012/03/15 13:37
S126	343	(polysilicon polycrystalline) same emitter and (photovoltaic solar near2 (Cell device battery))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2012/03/15 13:37
S130	86	S129 not S124	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2012/03/15 13:38
S131	2	"20090159111"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2012/03/15 13:43
S132	6	"2008004791"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2012/03/15 13:46
S133	10	"7468485"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO;	OR	OFF	2012/03/15 13:47

			DERWENT; IBM_TDB			
S134	24	("3961997" "4927770" "5030295" "5053083" "5057439" "5164019" "5360990" "5369291" "5641362" "6274402" "6313395" "6333457" "6337283" "6387726" "6423568" "6998288").PN. OR ("7468485").URPN.	US-PGPUB; USPAT; USOCR	OR	OFF	2012/03/15 13:49
S136	1	"20090159111"	US-PGPUB; USPAT; USOCR	OR	OFF	2012/03/15 13:55
S135	14	"5057439"	US-PGPUB; USPAT; USOCR	OR	OFF	2012/03/15 13:55
S137	23	("4090213" "4131486" "4133698" "4232245" "4255211" "4315097" "4316049" "4341918" "4365262" "4367368" "4385198" "4427839").PN. OR ("4665277").URPN.	US-PGPUB; USPAT; USOCR	OR	OFF	2012/03/15 13:58
S139	215	S126 not S129	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2012/03/15 14:03
S138	0	S129 not S126	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2012/03/15 14:03
S140	74	emitter and (photovoltaic solar near2 (Cell device battery)) and tunnel near oxide	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2012/03/15 14:04

S142	1	S141 not S140	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2012/03/15 14:10
S141	75	emitter and (photovoltaic solar near2 (Cell device battery)) and tunnel\$3 near oxide	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2012/03/15 14:10
S143	222	emitter and (photovoltaic solar near2 (Cell device battery)) and tunnel\$3 near5 (oxide barrier)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2012/03/15 14:11
S144	147	S143 not S141	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2012/03/15 14:12
S145	188	emitter and (photovoltaic solar near2 (Cell device battery)) and tunnel\$3 near2 (oxide barrier)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2012/03/15 14:22
S147	413	(photovoltaic solar near2 (Cell device battery)) and tunnel\$3 near2 (oxide barrier) and silicon	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2012/03/15 14:27

S146	488	(photovoltaic solar near2 (Cell device battery)) and tunnel\$3 near2 (oxide barrier)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2012/03/15 14:27
S148	238	S147 not S145	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2012/03/15 14:28
S149	24	("3961997" "4927770" "5030295" "5053083" "5057439" "5164019" "5360990" "5369291" "5641362" "6274402" "6313395" "6333457" "6337283" "6387726" "6423568" "6998288").PN. OR ("7468485").URPN.	US-PGPUB; USPAT; USOCR	OR	OFF	2012/03/15 14:32
S151	10	Sah.in. and emitter	US-PGPUB; USPAT; USOCR	OR	OFF	2012/03/15 14:35
S150	0	Sah.in. and emittter	US-PGPUB; USPAT; USOCR	OR	OFF	2012/03/15 14:35
S152	23	("4090213" "4131486" "4133698" "4232245" "4255211" "4315097" "4316049" "4341918" "4365262" "4367368" "4385198" "4427839").PN. OR ("4665277").URPN.	US-PGPUB; USPAT; USOCR	OR	OFF	2012/03/15 14:36
S154	11442	(photovoltaic solar near2 (Cell device battery)) and (passivat\$4 near2 oxide dielectric) and silicon	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2012/03/15 14:39
S153	4089	(photovoltaic solar near2 (Cell device battery)) and (passivat\$4 near2 oxide dielectric) and silicon and (passivat\$4	US-PGPUB; USPAT; USOCR; FPRS; EPO;	OR	OFF	2012/03/15 14:39

		near2 oxide dielectric) with (reflect\$4 metal)	JPO; DERWENT; IBM_TDB			
S159	612	(photovoltaic solar near (Cell battery)) and ((passivat\$4 near2 oxide) dielectric) and silicon and (passivat\$4 near2 oxide dielectric) with (reflect\$4 metal) and tunnel\$3 and silicon	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2012/03/15 14:40
S158	612	(photovoltaic solar near (Cell battery)) and ((passivat\$4 near2 oxide) dielectric) and silicon and (passivat\$4 near2 oxide dielectric) with (reflect\$4 metal) and tunnel\$3	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2012/03/15 14:40
S157	4063	(photovoltaic solar near (Cell battery)) and ((passivat\$4 near2 oxide) dielectric) and silicon and (passivat\$4 near2 oxide dielectric) with (reflect\$4 metal)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2012/03/15 14:40
S156	11276	(photovoltaic solar near (Cell battery)) and ((passivat\$4 near2 oxide) dielectric) and silicon	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2012/03/15 14:40
S155	11442	(photovoltaic solar near2 (Cell device battery)) and ((passivat\$4 near2 oxide) dielectric) and silicon	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2012/03/15 14:40
S161	301	S160 not S148	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO;	OR	OFF	2012/03/15 14:41

			DERWENT; IBM_TDB			
S160	301	(photovoltaic solar near (Cell battery)) and ((passivat\$4 near2 oxide) dielectric) and silicon and (passivat\$4 near2 oxide dielectric) with (reflect\$4 metal) and tunnel\$3 and emitter	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2012/03/15 14:41
S162	8	"5956571"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2012/03/15 14:57
S163	58	"4200472"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2012/03/15 14:58
S164	2	"20060130891"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2012/03/15 14:59
S165	50	Borden.in. and emitter	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2012/03/15 15:00
S166	13	"5057439"	USPAT	OR	OFF	2012/03/16 07:33
S168	2	"20090159111"	US-PGPUB; USPAT; USOCR;	OR	OFF	2012/03/16 07:36

			FPRS; EPO; JPO; DERWENT; IBM_TDB			
S167	0	"20090159111"	USPAT	OR	OFF	2012/03/16 07:36
S169	2	"20050268963"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2012/03/16 07:38
S170	24	("3961997" "4927770" "5030295" "5053083" "5057439" "5164019" "5360990" "5369291" "5641362" "6274402" "6313395" "6333457" "6337283" "6387726" "6423568" "6998288").PN. OR ("7468485").URPN.	US-PGPUB; USPAT; USOCR	OR	OFF	2012/03/16 07:45
S171	14	("4403392" "4502206").PN. OR ("5057439").URPN.	US-PGPUB; USPAT; USOCR	OR	OFF	2012/03/16 07:47
S173	1	"20090159111"	US-PGPUB; USPAT; USOCR	OR	OFF	2012/03/16 07:49
S172	1	"20060096635"	US-PGPUB; USPAT; USOCR	OR	OFF	2012/03/16 07:49
S174	1	"20050268963"	US-PGPUB; USPAT; USOCR	OR	OFF	2012/03/16 07:54
S175	114	polysilicon near emitter and native near oxide	US-PGPUB; USPAT; USOCR	OR	OFF	2012/03/16 08:12
S176	2	polysilicon near emitter and native near oxide and (photovoltaic and solar near2 (battery cell device))	US-PGPUB; USPAT; USOCR	OR	OFF	2012/03/16 08:13

S177	367	polysilicon near emitter and "SiO.sub.2"	US-PGPUB; USPAT; USOCR	OR	OFF	2012/03/16 08:14
S179	6	Borden.in. and polysilicon near emitter	US-PGPUB; USPAT; USOCR	OR	OFF	2012/03/16 08:15
S178	2	polysilicon near emitter and "SiO.sub.2" and (photovoltaic and solar near2 (battery cell device))	US-PGPUB; USPAT; USOCR	OR	OFF	2012/03/16 08:15
S180	10	polysilicon near emitter and (photovoltaic and solar near2 (battery cell device))	US-PGPUB; USPAT; USOCR	OR	OFF	2012/03/16 08:17
S181	17	(polycrystalline multicrystalline polysilicon) near2 emitter and (photovoltaic and solar near2 (battery cell device))	US-PGPUB; USPAT; USOCR	OR	OFF	2012/03/16 08:19
S182	0	"2008004791"	US-PGPUB; USPAT; USOCR	OR	OFF	2012/03/16 08:27
S185	6	"2008004791"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2012/03/16 08:28
S184	0	"2008004791"	US-PGPUB; USPAT; USOCR	OR	OFF	2012/03/16 08:28
S183	2	"20080004791"	US-PGPUB; USPAT; USOCR	OR	OFF	2012/03/16 08:28
S188	552	S187 and emitter and (photovoltaic solar near (cell device battery))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2012/03/19 08:37

S187	7338	438/72.ccls. 438/57.ccls. 438/69.ccls. 438/97.ccls. 438/98.ccls. 257/461.ccls. 257/436.ccls.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2012/03/19 08:37
S186	3869	438/72.ccls. 438/57.ccls. 438/69.ccls. 438/97.ccls. 438/98.ccls. 257/461.ccls. 257/436.ccls.	USPAT	OR	OFF	2012/03/19 08:37
S190	39	S188 and oxide and polysilicon	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2012/03/19 08:38
S189	426	S188 and oxide	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2012/03/19 08:38
S191	419	S188 and oxide and silicon	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2012/03/19 08:45
S192	237	S188 and oxide and (light near incident front) near5 (contact wir\$4 connect\$4)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2012/03/19 08:46
S193	12	S188 and oxide and (light near incident front) near5 (contact wir\$4 connect\$4) and tunnel\$3 near5 oxide	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO;	OR	OFF	2012/03/19 08:53

			DERWENT; IBM_TDB			
S196	2	"12070742"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/09/11 10:10
S195	16	"1270742"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/09/11 10:10
S194	2	"12707042"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/09/11 10:10
S197	31	("20030134469" "20040200520" "20050268963" "20060130891" "20060157103" "20070082206" "3961997" "4427839" "4665277" "4927770" "5030295" "5053083" "5057439" "5164019" "5217539" "5266125" "5360990" "5369291" "5449626" "5479018" "5641362" "6262359" "6274402" "6313395" "6333457" "6337283" "6387726" "6423568" "6524880" "6998288" "7135350").PN. OR ("8222516").URPN.	US-PGPUB; USPAT; USOCR	OR	ON	2013/09/11 10:11
S199	2	"11915984"	US-PGPUB; USPAT; USOCR	OR	ON	2013/09/11 10:26
S198	1	"20040055894"	US-PGPUB; USPAT; USOCR	OR	ON	2013/09/11 10:26

S200	2	"20090159111"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/09/11 10:32
S201	42	("3961997" "4927770" "5030295" "5053083" "5057439" "5164019" "5360990" "5369291" "5641362" "6274402" "6313395" "6333457" "6337283" "6387726" "6423568" "6998288").PN. OR ("7468485").URPN.	US-PGPUB; USPAT; USOCR	OR	ON	2013/09/11 10:35
S202	26	"5057439"	US-PGPUB; USPAT; USOCR	OR	ON	2013/09/11 10:41
S203	26	("4403392" "4502206").PN. OR ("5057439").URPN.	US-PGPUB; USPAT; USOCR	OR	ON	2013/09/11 10:42
S204	1	"12983846"	US-PGPUB; USPAT; USOCR	OR	ON	2013/09/11 10:50
S205	33	polysilicon near emitter and (solar photovoltaic).ab.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/09/11 10:51
S207	30	"7468485"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/09/11 10:54
S206	3	"7468482"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO;	OR	ON	2013/09/11 10:54

			DERWENT; IBM_TDB			
S209	1	2009-P84539.NRAN.	DERWENT	OR	ON	2013/09/11 11:01
S208	2	"20090288704"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/09/11 11:01
S210	3	"20070256728"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/09/11 11:03
S212	55	polysilicon near emitter and (solar photovoltaic)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/09/11 11:08
S211	2074	polysilicon near emitter	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/09/11 11:08
S214	17	S213 not S212	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/09/11 11:14
S213	72	polysilicon near5 emitter and (solar photovoltaic)	US-PGPUB; USPAT; USOCR;	OR	ON	2013/09/11 11:14

			FPRS; EPO; JPO; DERWENT; IBM_TDB			
S215	6	"2008004791"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/09/11 11:15
S216	24	(polycrystalline multicrystalline polysilicon) near2 emitter and (photovoltaic and solar near2 (battery cell device))	US-PGPUB; USPAT; USOCR	OR	OFF	2013/09/11 11:17
S217	4	lindholm.in. and solar near cell	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/09/11 11:54
S219	3	lindholm.in. and "136".clas.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/09/11 11:56
S218	0	lindholm.in. and "136."	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/09/11 11:56
S220	2	polysilicon near solar same emitter	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO;	OR	ON	2013/09/11 11:59

			DERWENT; IBM_TDB			
S221	20	("3900943" "4062038" "4171997" "4197141" "4219368" "4230508" "4249957" "4278473" "4283589" "4320168" "4366338").PN. OR ("4431858").URPN.	US-PGPUB; USPAT; USOCR	OR	ON	2013/09/11 12:00
S222	6	("20030183270" "20090255574" "20090283138" "3969163" "4431858" "4571448").PN. OR ("8283557").URPN.	US-PGPUB; USPAT; USOCR	OR	ON	2013/09/11 12:02
S223	26	("4403392" "4502206").PN. OR ("5057439").URPN.	US-PGPUB; USPAT; USOCR	OR	ON	2013/09/11 13:29
S224	2	"12166266"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/09/11 13:43
S227	26	polysilicon near5 emitter same oxide with dop\$3 same phosphorus	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/09/11 13:45
S226	377	polysilicon near5 emitter same oxide with dop\$3	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/09/11 13:45
S225	395	polysilicon near5 emitter same oxide same dopant	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/09/11 13:45

S228	6	"11201817"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/09/11 13:48
S229	53	Swanson near Richard and solar near cell	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/09/11 13:52
S230	158	"5053083"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/09/11 13:53
S231	38	("20040200520" "4234352" "4478879" "4920639" "4927770" "5053083" "5320684" "5538564" "5641362" "6624737").PN. OR ("7339110").URPN.	US-PGPUB; USPAT; USOCR	OR	ON	2013/09/11 14:03
S232	687	phosphosilicate near glass same (dielectric oxide) with (passivation capping)	US-PGPUB; USPAT; USOCR	OR	ON	2013/09/11 14:14
S233	41	phosphosilicate near glass same (dielectric oxide) with (passivation capping) same polysilicon	US-PGPUB; USPAT; USOCR	OR	ON	2013/09/11 14:15
S236	59	"5693578"	US-PGPUB; USPAT; USOCR	OR	ON	2013/09/11 14:17
S235	2	"20080004791"	US-PGPUB; USPAT; USOCR	OR	ON	2013/09/11 14:17

S234	0	"2008004791"	US-PGPUB; USPAT; USOCR	OR	ON	2013/09/11 14:17
S237	11	(back near surface near field BSF) same polysilicon	US-PGPUB; USPAT; USOCR	OR	ON	2013/09/11 14:19
S239	3	S238 not S237	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/09/11 14:21
S238	14	(back near surface near field BSF) same polysilicon	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/09/11 14:21
S241	81	S240 not S238	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/09/11 14:23
S240	81	(back near surface near field BSF) same polycrystalline near silicon	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/09/11 14:23
S243	143	S242 not S238	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/09/11 14:35

S242	157	(back near surface near field BSF) and polysilicon	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/09/11 14:35
S245	108	(back near surface near field BSF) same passivat\$4 and (solar photovoltaic).ab. and heterojunction	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/09/11 14:45
S244	476	(back near surface near field BSF) same passivat\$4 and (solar photovoltaic).ab.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/09/11 14:45
S246	26	"4315097"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/09/11 15:00
S248	3	"20040200520"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/09/11 15:02
S247	2	"20040205520"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/09/11 15:02

S249	25	(back near surface near field BSF) same passivat\$4 and (solar photovoltaic).ab. and polysilicon	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/09/11 15:09
S250	717	(back near surface near field BSF) same (capping oxide dielectric passivat\$4) and (solar photovoltaic).ab.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/09/11 15:10
S251	75	(back near surface near field BSF) same (capping oxide dielectric passivat\$4) and (solar photovoltaic).ab. and Phosphosilicate	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/09/11 15:11
S253	39	S252 not S251	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/09/11 15:16
S252	114	(back near surface near field BSF) same (capping oxide dielectric passivat\$4) and (solar photovoltaic).ab. and (Phosphosilicate PSG)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/09/11 15:16
S255	44	S254 not S252	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/09/11 15:18

S254	158	(back near surface near field BSF) same (capping oxide dielectric passivat\$4) and (Phosphosilicate PSG)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/09/11 15:18
S256	1163	(back near surface near field BSF) same (capping oxide dielectric passivat\$4)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/09/11 15:20
S258	33	(back near surface near field BSF) same (capping oxide dielectric passivat\$4) and (solar photovoltaic photoelectric).ab. and polysilicon	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/09/11 15:21
S257	727	(back near surface near field BSF) same (capping oxide dielectric passivat\$4) and (solar photovoltaic photoelectric).ab.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/09/11 15:21
S259	703	polysilicon with PSG with (dielectric oxide)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/09/11 15:30
S260	81	polysilicon with PSG with (dielectric oxide) and emitter	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/09/11 15:31

S261	225	polysilicon with PSG with (dielectric oxide) same dop\$3	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/09/11 15:33
S263	44	polysilicon with PSG with (dielectric oxide) and (solar photovoltaic)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/09/11 15:34
S262	2	polysilicon with PSG with (dielectric oxide) same dop\$3 and (solar photovoltaic)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/09/11 15:34
S265	62	(phosphosilicate PSG) with (dielectric oxide) same dop\$4 and (solar photovoltaic).ab.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/09/11 15:35
S264	161	(phosphosilicate PSG) with (dielectric oxide) same dop\$4 and (solar photovoltaic)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/09/11 15:35
S267	41	S266 not S265	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/09/11 15:42

S266	103	(phosphosilicate PSG borosilicate BSG) with (dielectric oxide) same dop\$4 and (solar photovoltaic).ab.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/09/11 15:42
S268	2	"20080173347"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/09/11 15:43
S269	3	"20060196535"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/09/11 15:45
S270	179	"4927770"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/09/11 15:46
S271	57	(phosphosilicate PSG borosilicate BSG) with (dielectric oxide cap\$4) same dop\$4 and (back near surface near field BSF)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/09/11 15:50
S273	0	S271 not S271	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/09/11 15:52

S272	145	(phosphosilicate PSG borosilicate BSG) with (dielectric oxide cap\$4) and (back near surface near field BSF)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/09/11 15:52
S274	88	S272 not S271	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/09/11 15:53
S275	190	(phosphosilicate PSG borosilicate BSG) with (dielectric oxide cap\$4) with (dop\$4) with (burn\$4 escap\$4 leav\$4 diffus\$4)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/09/12 07:22
S276	130	(phosphosilicate PSG borosilicate BSG) with (dielectric "SiO.sub.2" silicon near oxide cap\$4) with (dop\$4) with (burn\$4 escap\$4 leav\$4 diffus\$4)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/09/12 07:28
S277	341	(phosphosilicate PSG borosilicate BSG) with (dielectric "SiO.sub.2" silicon near oxide cap\$4) and (solar photoelectric photovoltaic).ab.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/09/12 07:39
S278	14	(phosphosilicate PSG borosilicate BSG) with (dielectric "SiO.sub.2" silicon near oxide cap\$4) with (dop\$4) with (burn\$4 escap\$4 leav\$4 diffus\$4) and (solar photoelectric photovoltaic).ab.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/09/12 07:42

S279	23	(phosphosilicate PSG borosilicate BSG) with (dielectric "SiO.sub.2" silicon near oxide cap\$4) with (dop\$4) with (burn\$4 escap\$4 leav\$4 diffus\$4) and (solar photoelectric photovoltaic)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/09/12 07:44
S280	18	(phosphosilicate PSG borosilicate BSG) with (cap\$4) with (dop\$4) and (solar photoelectric photovoltaic)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/09/12 07:46
S281	35	("3895975" "4056879" "4106047" "4131486" "4226017" "4916503" "5538564" "5641362" "5951742" "5973260" "6071753").PN. OR ("6262359").URPN.	US-PGPUB; USPAT; USOCR	OR	ON	2013/09/12 09:04
S282	6	(oxide with tunnel) same (pn near junction) and (solar photovoltaic).ab.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/09/12 09:08
S285	80	S284 not S283	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/09/12 09:10
S284	86	(oxide with tunnel\$5) same (junction) and (solar photovoltaic).ab.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/09/12 09:10
S283	6	(oxide with tunnel\$5) same (pn near junction) and (solar photovoltaic).ab.	US-PGPUB; USPAT; USOCR;	OR	ON	2013/09/12 09:10

			FPRS; EPO; JPO; DERWENT; IBM_TDB			
S286	3	"20070256728"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/09/12 09:12
S287	52	"4272641"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/09/12 09:14
S290	87	S289 not S287	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/09/12 09:15
S289	88	thin same (oxide with tunnel\$5) and (solar photovoltaic).ab.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/09/12 09:15
S288	211	(oxide with tunnel\$5) and (solar photovoltaic).ab.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/09/12 09:15
S291	1100	(oxide with tunnel\$5) and (solar photovoltaic photoelectric)	US-PGPUB; USPAT; USOCR; FPRS; EPO;	OR	ON	2013/09/12 09:22

			JPO; DERWENT; IBM_TDB			
S293	243	(S292 not S289)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/09/12 09:24
S292	301	(oxide with tunnel\$5) same (pn junction p-type n-type) and (solar photovoltaic photoelectric)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/09/12 09:24
S295	6	("3990097" "4338482").PN. OR ("4495375").URPN.	US-PGPUB; USPAT; USOCR	OR	ON	2013/09/12 09:31
S294	7	"4495375"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/09/12 09:31
S296	24	("3559281" "4013485" "4062102" "4253881" "4403239" "4404421" "4404422" "4495375" "4640002" "4806496" "4828628").PN. OR ("4891325").URPN.	US-PGPUB; USPAT; USOCR	OR	ON	2013/09/12 09:32
S297	60	"6998288"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/09/12 09:41

S298	53	("20040200520" "4927770" "5053083" "5164019" "5217539" "5360990" "5369291" "6274402" "6313395" "6333457" "6337283" "6387726" "6423568").PN. OR ("6998288").URPN.	US-PGPUB; USPAT; USOCR	OR	ON	2013/09/12 09:55
S299	23	Sunpower.as. and oxide.clm.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/09/12 10:35
S300	5	"12070742"	US-PGPUB; USPAT; USOCR	OR	OFF	2016/06/08 09:05
S301	5181	tunneling near2 oxide	US-PGPUB; USPAT; USOCR	OR	OFF	2016/06/08 09:19
S302	205	tunnel\$4 near2 oxide and (solar photovoltaic) and (rear\$4 back\$4) near2 (electrode contact) and (passivat\$4 anti?reflect\$4 ARC)	US-PGPUB; USPAT; USOCR	OR	OFF	2016/06/08 09:20
S304	5	S303 not S302	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2016/06/08 09:29
S303	210	tunnel\$4 near2 oxide and (solar photovoltaic) and (rear\$4 back\$4) near2 (electrode contact) and (passivat\$4 anti?reflect\$4 ARC)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2016/06/08 09:29
S305	238	(heterojunction) and (solar photovoltaic) and (rear\$4 back\$4) near2 (electrode contact) and (passivat\$4 anti?reflect\$4	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO;	OR	OFF	2016/06/08 09:31

		ARC) and (polysilicon polycrystalline) same (wafer monocrystalline)	DERWENT; IBM_TDB			
S306	99	"7468485"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2016/06/08 09:46
S307	66	"6262359"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2016/06/08 09:49
S308	421	(heterojunction) and (solar photovoltaic) and (passivat\$4 anti?reflect\$4 ARC) and (polysilicon polycrystalline) same (wafer monocrystalline)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2016/06/08 10:20
S309	183	S308 not S305	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2016/06/08 10:21
S310	49	"5030295"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2016/06/08 10:23
S311	129	("4602120" "4675468" "4703553" "4726850" "4781766" "4824489" "5030295" "5053083" "5346850").PN. OR ("5538564").URPN.	US-PGPUB; USPAT; USOCR	OR	ON	2016/06/08 10:25

S312	248	tunnel\$4 near2 oxide and (solar photovoltaic) and (rear\$4 back\$4) near2 (electrode contact)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2016/06/08 10:43
S314	105	S313 not S302	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2016/06/08 10:44
S313	199	tunnel\$4 near2 oxide and (solar photovoltaic) and (polysilicon polycrystalline) same (wafer monocrystalline)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2016/06/08 10:44
S315	516	(solar photovoltaic) and (polysilicon polycrystalline) with emitter	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2016/06/08 10:48
S316	115	(solar photovoltaic) and (polysilicon polycrystalline) with emitter and heterojunction	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2016/06/08 10:49
S318	442	(solar photovoltaic) and (polysilicon polycrystalline multicrystalline silicon Si) with emitter and heterojunction and (polysilicon polycrystalline multicrystalline)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2016/06/08 10:59

S317	635	(solar photovoltaic) and (polysilicon polycrystalline multicrystalline silicon) with emitter and heterojunction	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2016/06/08 10:59
S319	327	S318 not S316	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2016/06/08 11:00
S320	51	("4403392" "4502206").PN. OR ("5057439").URPN.	US-PGPUB; USPAT; USOCR	OR	ON	2016/06/08 11:09
S321	8	("20030089393" "20060255340" "20060263642" "4703553" "5011565" "5057439" "6403877" "7858430").PN. OR ("8207443").URPN.	US-PGPUB; USPAT; USOCR	OR	ON	2016/06/08 11:12
S322	34	"5030295"	US-PGPUB; USPAT; USOCR	OR	ON	2016/06/08 11:16
S325	275	S324 not S319	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2016/06/08 11:20
S324	380	tunnel\$4 and (solar photovoltaic) and heterojunction and emitter and heterojunction and (polysilicon polycrystalline multicrystalline)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2016/06/08 11:20
S323	1803	tunnel\$4 and (solar photovoltaic) and heterojunction	US-PGPUB; USPAT; USOCR; FPRS; EPO;	OR	OFF	2016/06/08 11:20

			JPO; DERWENT; IBM_TDB			
S326	3	"20060263642"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2016/06/08 11:22
S328	427	S327 not S324	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2016/06/08 11:23
S327	807	tunnel\$4 and (solar photovoltaic) and heterojunction and emitter	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2016/06/08 11:23
S329	35	"5563092"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2016/06/08 12:23
S333	147	polycrystalline same (thin tunnel\$3) near2 oxide same (monocrystalline wafer crystalline) and (solar photovoltaic)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2016/06/08 12:25
S332	1066	polycrystalline same (thin tunnel\$3) near2 oxide same (monocrystalline wafer crystalline)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO;	OR	ON	2016/06/08 12:25

			DERWENT; IBM_TDB			
S331	11587	polycrystalline and (thin tunnel\$3) near2 oxide and crystalline	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2016/06/08 12:25
S330	516761	polycrystalline and (thin tunnel\$3) oxide and crystalline	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2016/06/08 12:25
S334	282	(polysilicon polycrystalline) same (thin tunnel\$3) near2 oxide same (monocrystalline wafer crystalline) and (solar photovoltaic)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2016/06/08 12:30
S335	27	(emitter) with (thin tunnel\$3) near2 oxide same (monocrystalline wafer crystalline) and (solar photovoltaic)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2016/06/08 12:39
S336	28	(emitter) with (thin tunnel\$3 interfacial) near2 oxide same (monocrystalline wafer crystalline) and (solar photovoltaic)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2016/06/08 12:40
S337	1098	(thin tunnel\$3) near2 oxide and heterojunction and (solar photovoltaic)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO;	OR	ON	2016/06/08 12:42

			DERWENT; IBM_TDB			
S340	405	S339 not S328	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2016/06/08 12:43
S339	432	(thin tunnel\$3) near2 oxide and heterojunction and (solar photovoltaic).ab.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2016/06/08 12:43
S341	176	(interfacial interface tunnel\$3) near2 oxide and heterojunction and (solar photovoltaic).ab.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2016/06/08 12:46
S342	3	"20070256728"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2016/06/08 12:49
S343	16	emitter with interfacial near oxide and (solar photovoltaic)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2016/06/08 13:02
S344	24	("3919639" "4296372" "4431460" "4464627" "4467519" "4483726" "4598249" "4609867" "4695794" "4709141" "4859939" "4956603").PN. OR ("5138256").URPN.	US-PGPUB; USPAT; USOCR	OR	ON	2016/06/08 13:05

S345	353	(interfacial interface tunnel\$3) near2 oxide same (polysilicon polycrystalline) and (solar photovoltaic)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2016/06/08 13:06
S346	356	(interfacial interface tunnel\$3) near2 oxide same (polysilicon polycrystalline multicrystalline) and (solar photovoltaic)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2016/06/08 13:09
S347	449	(interfacial interface tunnel\$3 silicon) near2 oxide with (interfac\$3 tunnel\$) same (polysilicon polycrystalline) and (solar photovoltaic)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2016/06/08 13:14
S348	62	tunneling near oxide and (solar photovoltaic).ab.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2016/06/08 13:23
S350	123	(inversion with oxide tunneling near oxide) and (solar photovoltaic).ab.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2016/06/08 13:25
S349	2632	(inversion tunneling near oxide) and (solar photovoltaic).ab.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2016/06/08 13:25

S351	276	(inversion with oxide tunnel\$3 near oxide) and (solar photovoltaic).ab.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2016/06/08 13:26
S353	153	S352 not S350	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2016/06/08 13:27
S352	222	(tunnel\$3 near oxide) and (solar photovoltaic).ab.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2016/06/08 13:27
S354	35	"5563092"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2016/06/08 13:37
S358	62	polysilicon with interfac\$4 near3 oxide with (crystalline single near crystal wafer)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2016/06/08 13:38
S357	0	polysilicon with interfac\$4 near3 oxide with growth with (crystalline single near crystal wafer)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2016/06/08 13:38

S356	17344	polysilicon with interfac\$4 oxide with growth with (crystalline single near crystal wafer)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2016/06/08 13:38
S355	84638	polysilicon with interfac\$4 oxide with growth	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2016/06/08 13:38
S359	142	"5011565"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2016/06/08 15:47
S360	72	"5057439"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2016/06/08 15:51
S361	6	"7858430"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2016/06/08 15:54
S362	17	(anti?reflect\$4) with (stack) with ITO and (solar photovoltaic)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2016/06/08 16:15

S363	4439	(aluminum Al) with (silver Ag) with electrode and (solar photovoltaic).ab.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2016/06/08 17:20
S364	660	(aluminum Al) with (silver Ag) with electrode and (solar photovoltaic).ab. and BSF	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2016/06/08 17:21
S365	51	("4403392" "4502206").PN. OR ("5057439").URPN.	US-PGPUB; USPAT; USOCR	OR	ON	2016/06/08 17:40
S366	212	(polycrystalline polysilicon) near2 emitter and (solar photovoltaic)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2016/06/08 17:51
S367	689	(polycrystalline polysilicon) and BSF and (single near crystal\$4 monocrystalline) near5 substrate and (solar photovoltaic)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2016/06/08 17:52
S369	507	(polycrystalline polysilicon) and (FSF BSF) and (single near crystal\$4 monocrystalline) near5 substrate and (solar photovoltaic).ab.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2016/06/08 17:53
S368	699	(polycrystalline polysilicon) and (FSF BSF) and (single near crystal\$4 monocrystalline) near5 substrate and (solar photovoltaic)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO;	OR	ON	2016/06/08 17:53

			DERWENT; IBM_TDB			
S370	63	(polycrystalline polysilicon) and (FSF) and (single near crystal\$4 monocrystalline) near5 substrate and (solar photovoltaic).ab.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2016/06/08 17:54
S371	93	(FSF) and (single near crystal\$4 monocrystalline) near5 substrate and (solar photovoltaic).ab.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2016/06/08 17:55
S372	30	S371 not S370	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2016/06/08 17:56
S373	186	(FSF front near2 surface near field) and (single near crystal\$4 monocrystalline) near5 substrate and (solar photovoltaic).ab.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2016/06/08 17:57
S375	172	S374 not S371	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2016/06/08 17:58
S374	265	(FSF front near2 surface near field) and (single near crystal\$4 monocrystalline wafer) near5 substrate and (solar photovoltaic).ab.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO;	OR	ON	2016/06/08 17:58

			DERWENT; IBM_TDB			
S377	53	Veschetti.in. and photovoltaic	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2016/06/08 18:02
S376	71	Veschetti.in.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2016/06/08 18:02
S378	1	2008-D39688.NRAN.	DERWENT	OR	ON	2016/06/08 18:03
S379	7	"2003083955"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2016/06/08 18:04
S380	19	"5134090"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2016/06/08 18:06
S381	2	("20030183270" "5057439").PN.	US-PGPUB; USPAT	OR	ON	2016/06/08 18:21
S382	2	"20030183270"	US-PGPUB; USPAT	OR	ON	2016/06/08 18:25
S383	2	("8222516" "8878053").PN.	US-PGPUB; USPAT	OR	ON	2016/06/08 18:29
S384	32	(H01L31/0236 H01L31/0745 H01L31/1804 H01L31/022425	US-PGPUB; USPAT;	OR	ON	2016/06/08 18:44

		H01L31/068 H01L31/182 H01L31/056).cpc. and (Y02E10/52 Y02P70/521 Y02E10/547).cpc. and (polysilicon polycrystalline) near emitter and tunnel\$3 near oxide	USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB			
S385	1	"14504771"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2016/10/05 10:07
S387	19	S386 and emitter with (back\$4 rear\$4)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2016/10/05 10:10
S386	76	(US-20050268963-\$ or US- 20020153039-\$ or US-20060196535-\$ or US-20090101199-\$ or US-20040097062- \$ or US-20040112426-\$ or US- 20070186970-\$ or US-20050272175-\$ or US-20040063326-\$ or US-20100224238- \$ or US-20100000597-\$ or US- 20070256728-\$ or US-20060060238-\$ or US-20080092944-\$ or US-20110162706- \$ or US-20070151598-\$ or US- 20080092951-\$ or US-20110104618-\$ or US-20080223446-\$ or US-20070151599- \$ or US-20090205712-\$ or US- 20100186803-\$ or US-20090142880-\$ or US-20060255340-\$ or US-20050017257- \$ or US-20100186802-\$).did. or (US- 20020142500-\$ or US-20040003836-\$ or US-20100087031-\$).did. or (US- 4379944-\$ or US-4665277-\$ or US- 5320684-\$ or US-6210991-\$ or US- 5792280-\$ or US-5899704-\$ or US- 6262359-\$ or US-5258077-\$ or US- 6071753-\$ or US-7468485-\$ or US- 7838400-\$ or US-5641362-\$ or US- 8222516-\$ or US-3961997-\$ or US- 5057439-\$ or US-8207443-\$ or US- 5138256-\$ or US-7633006-\$ or US-	US-PGPUB; USPAT; FPRS; EPO; DERWENT	OR	ON	2016/10/05 10:10

		6130380-\$ or US-5738731-\$ or US-4927770-\$ or US-6624049-\$ or US-4152824-\$ or US-6214743-\$ or US-7029943-\$ or US-6998288-\$).did. or (US-8878053-\$ or US-8207444-\$ or US-5538564-\$ or US-7566974-\$ or US-5030295-\$ or US-6407012-\$ or US-5563092-\$ or US-7858430-\$ or US-7554031-\$).did. or (WO-2009094578-\$ or WO-2009094578-\$).did. or (WO-2009094578-\$).did. or (US-20090205712-\$ or US-20080121279-\$ or WO-2007130188-\$ or US-7468485-\$ or JP-07106611-\$ or US-20040200520-\$ or JP-2004247364-\$ or US-5030295-\$ or WO-03083955-\$).did.				
S388	5	"20060048809"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2016/10/06 09:33
S389	10	"2007106611"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2017/01/10 15:14
S390	5	"07106611"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2017/01/10 15:16
S391	5	"07106611"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2017/01/18 11:38

S392	2	"12421570"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2017/01/31 10:50
S393	116	"7468485"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2017/01/31 10:53
S394	70	"6262359"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2017/04/14 09:47
S395	23	"2009094578"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2017/04/14 10:09
S396	1	"14504771"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2017/04/17 11:21
S397	23	"2009094578"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2017/04/17 11:40

S399	18	"2009031886"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2017/04/17 15:34
S398	23	"2009094578"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2017/04/17 15:34
S400	1	"14504771"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2017/06/26 09:27
S401	73	"6262359"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2017/06/26 09:30
S402	76	(US-20050268963-\$ or US-20020153039-\$ or US-20060196535-\$ or US-20090101199-\$ or US-20040097062-\$ or US-20040112426-\$ or US-20070186970-\$ or US-20050272175-\$ or US-20040063326-\$ or US-20100224238-\$ or US-20100000597-\$ or US-20070256728-\$ or US-20060060238-\$ or US-20080092944-\$ or US-20110162706-\$ or US-20070151598-\$ or US-20080092951-\$ or US-20110104618-\$ or US-20080223446-\$ or US-20070151599-\$ or US-20090205712-\$ or US-20100186803-\$ or US-20090142880-\$ or US-20060255340-\$ or US-20050017257-\$ or US-20100186802-\$).did. or (US-20020142500-\$ or US-20040003836-\$ or	US-PGPUB; USPAT; FPRS; EPO; DERWENT	OR	ON	2017/06/26 09:33

		US-2010087031-\$).did. or (US-4379944-\$ or US-4665277-\$ or US-5320684-\$ or US-6210991-\$ or US-5792280-\$ or US-5899704-\$ or US-6262359-\$ or US-5258077-\$ or US-6071753-\$ or US-7468485-\$ or US-7838400-\$ or US-5641362-\$ or US-8222516-\$ or US-3961997-\$ or US-5057439-\$ or US-8207443-\$ or US-5138256-\$ or US-7633006-\$ or US-6130380-\$ or US-5738731-\$ or US-4927770-\$ or US-6624049-\$ or US-4152824-\$ or US-6214743-\$ or US-7029943-\$ or US-6998288-\$).did. or (US-8878053-\$ or US-8207444-\$ or US-5538564-\$ or US-7566974-\$ or US-5030295-\$ or US-6407012-\$ or US-5563092-\$ or US-7858430-\$ or US-7554031-\$).did. or (WO-2009094578-\$ or WO-2009094578-\$).did. or (WO-2009094578-\$).did. or (US-20090205712-\$ or US-20080121279-\$ or WO-2007130188-\$ or US-7468485-\$ or JP-07106611-\$ or US-20040200520-\$ or JP-2004247364-\$ or US-5030295-\$ or WO-03083955-\$).did.				
S403	25	S402 and (contact near2 (resistance resistivi\$3))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2017/06/26 09:34
S404	787	(solar photovoltaic).ab. and (contact near2 (resistance resistivi\$3)) near7 (dop\$3 diffus\$4)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2017/06/26 09:39
S405	678	(solar photovoltaic).ab. and (contact near2 (resistance resistivi\$3)) near7 (dop\$3 diffus\$4) and (crystal\$4 wafer)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO;	OR	ON	2017/06/26 09:43

			DERWENT; IBM_TDB			
S406	230	(solar photovoltaic).ab. and (contact near2 (resistance resistivi\$3)) near7 (dop\$3 diffus\$4) and (crystal\$4 wafer) and ohms	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2017/06/26 09:46
S409	196	(solar photovoltaic).ab. and (contact near2 (resistance resistivi\$3)) near7 (dop\$3 diffus\$4) and (crystal\$4 wafer) and omega	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2017/06/26 09:51
S408	1	S400 and omega	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2017/06/26 09:51
S410	14	("3620829" "4078945" "4227942" "4640001" "4675466").PN. OR ("5759292").URPN.	US-PGPUB; USPAT; USOCR	OR	ON	2017/06/26 10:16
S411	66	(solar photovoltaic).ab. and (contact near2 (resistance resistivi\$3)) near7 (dop\$3 diffus\$4) same omega	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2017/06/26 10:20
S413	153	S412 not S411	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2017/06/26 10:22

S412	219	(solar photovoltaic).ab. and (contact near2 (resistance resistivi\$3)) same omega	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2017/06/26 10:22
S415	1	2007-797066.NRAN.	DERWENT	OR	ON	2017/06/26 10:26
S414	9	"20090017606"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2017/06/26 10:26
S416	1	2007-797066.NRAN.	DERWENT	OR	ON	2017/06/26 10:28
S417	120	"4152824"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2017/06/26 10:29
S419	107	S418 not S412	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2017/06/26 11:07
S418	209	(solar photovoltaic).ab. and (contact near2 (resistance resistivi\$3)) near7 (dop\$3 diffus\$4) and omega	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2017/06/26 11:07
S420	131	(solar photovoltaic).ab. and (contact near2 (resistance resistivi\$3)) near7	US-PGPUB; USPAT; USOCR;	OR	ON	2017/06/26 11:18

		(dop\$3 diffus\$4) and (back rear) near2 (junction)	FPRS; EPO; JPO; DERWENT; IBM_TDB			
S421	3	"20100197126"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2017/06/26 11:23
S422	210	"6429037"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2017/06/26 11:25
S424	34	S423 and polysilicon	US-PGPUB; USPAT; FPRS; EPO; DERWENT	OR	ON	2017/06/26 12:56
S423	82	(US-20050268963-\$ or US-20020153039-\$ or US-20060196535-\$ or US-20090101199-\$ or US-20040097062-\$ or US-20040112426-\$ or US-20070186970-\$ or US-20050272175-\$ or US-20040063326-\$ or US-20100224238-\$ or US-20100000597-\$ or US-20070256728-\$ or US-20060060238-\$ or US-20080092944-\$ or US-20110162706-\$ or US-20070151598-\$ or US-20080092951-\$ or US-20110104618-\$ or US-20080223446-\$ or US-20070151599-\$ or US-20090205712-\$ or US-20100186803-\$ or US-20090142880-\$ or US-20060255340-\$ or US-20050017257-\$ or US-20100186802-\$).did. or (US-20020142500-\$ or US-20040003836-\$ or US-20100087031-\$ or US-20090017606-\$ or US-20090183768-\$ or US-20110139231-\$).did. or (US-4379944-\$ or US-4665277-\$ or US-5320684-\$ or US-6210991-\$ or US-5792280-\$ or US-5899704-\$ or US-6262359-\$ or US-	US-PGPUB; USPAT; FPRS; EPO; DERWENT	OR	ON	2017/06/26 12:56

		5258077-\$ or US-6071753-\$ or US-7468485-\$ or US-7838400-\$ or US-5641362-\$ or US-8222516-\$ or US-3961997-\$ or US-5057439-\$ or US-8207443-\$ or US-5138256-\$ or US-7633006-\$ or US-6130380-\$ or US-5738731-\$ or US-4927770-\$ or US-6624049-\$ or US-4152824-\$ or US-6214743-\$ or US-7029943-\$ or US-6998288-\$).did. or (US-8878053-\$ or US-8207444-\$ or US-5538564-\$ or US-7566974-\$ or US-5030295-\$ or US-6407012-\$ or US-5563092-\$ or US-7858430-\$ or US-7554031-\$ or US-5759292-\$ or US-6429037-\$).did. or (WO-2009094578-\$ or WO-2009094578-\$).did. or (WO-2009094578-\$).did. or (US-20090205712-\$ or US-20080121279-\$ or WO-2007130188-\$ or US-7468485-\$ or JP-07106611-\$ or US-20040200520-\$ or JP-2004247364-\$ or US-5030295-\$ or WO-03083955-\$ or WO-2007082760-\$).did.				
S427	1235	(silicon near nitride "Si.sub.3N.sub.4") near5 dielectric and (solar photovoltaic).ab.	US-PGPUB; USPAT; FPRS; EPO; DERWENT	OR	ON	2017/06/26 13:59
S426	1931	(silicon near nitride "Si.sub.3N.sub.4") with dielectric and (solar photovoltaic).ab.	US-PGPUB; USPAT; FPRS; EPO; DERWENT	OR	ON	2017/06/26 13:59
S425	105792	(silicon near nitride "Si.sub.3N.sub.4") with dielectric	US-PGPUB; USPAT; FPRS; EPO; DERWENT	OR	ON	2017/06/26 13:59
S429	373	(silicon near nitride "Si.sub.3N.sub.4") near8 (titanium dioxide "TiO.sub.2") with dielectric and (solar photovoltaic).ab. and H01L31\$.cpc.	US-PGPUB; USPAT; FPRS; EPO; DERWENT	OR	ON	2017/06/26 14:00
S428	785	(silicon near nitride "Si.sub.3N.sub.4") near5 dielectric and (solar photovoltaic).ab. and H01L31\$.cpc.	US-PGPUB; USPAT; FPRS; EPO; DERWENT	OR	ON	2017/06/26 14:00

S430	91	(silicon near nitride "Si.sub.3N.sub.4") near8 (titanium near dioxide "TiO.sub.2") with dielectric and (solar photovoltaic).ab. and H01L31\$.cpc.	US-PGPUB; USPAT; FPRS; EPO; DERWENT	OR	ON	2017/06/26 14:01
S432	17	S431 and omega	US-PGPUB; USPAT; FPRS; EPO; DERWENT	OR	ON	2017/06/26 14:59
S431	82	(US-20050268963-\$ or US-20020153039-\$ or US-20060196535-\$ or US-20090101199-\$ or US-20040097062-\$ or US-20040112426-\$ or US-20070186970-\$ or US-20050272175-\$ or US-20040063326-\$ or US-20100224238-\$ or US-20100000597-\$ or US-20070256728-\$ or US-20060060238-\$ or US-20080092944-\$ or US-20110162706-\$ or US-20070151598-\$ or US-20080092951-\$ or US-20110104618-\$ or US-20080223446-\$ or US-20070151599-\$ or US-20090205712-\$ or US-20100186803-\$ or US-20090142880-\$ or US-20060255340-\$ or US-20050017257-\$ or US-20100186802-\$).did. or (US-20020142500-\$ or US-20040003836-\$ or US-20100087031-\$ or US-20090017606-\$ or US-20090183768-\$ or US-20110139231-\$).did. or (US-4379944-\$ or US-4665277-\$ or US-5320684-\$ or US-6210991-\$ or US-5792280-\$ or US-5899704-\$ or US-6262359-\$ or US-5258077-\$ or US-6071753-\$ or US-7468485-\$ or US-7838400-\$ or US-5641362-\$ or US-8222516-\$ or US-3961997-\$ or US-5057439-\$ or US-8207443-\$ or US-5138256-\$ or US-7633006-\$ or US-6130380-\$ or US-5738731-\$ or US-4927770-\$ or US-6624049-\$ or US-4152824-\$ or US-6214743-\$ or US-7029943-\$ or US-6998288-\$).did. or (US-8878053-\$ or US-8207444-\$ or US-5538564-\$ or US-7566974-\$ or US-5030295-\$ or US-6407012-\$ or US-5563092-\$ or US-7858430-\$ or US-7554031-\$ or US-5759292-\$ or US-6429037-\$).did. or (WO-2009094578-\$ or WO-2009094578-	US-PGPUB; USPAT; FPRS; EPO; DERWENT	OR	ON	2017/06/26 14:59

		\$.did. or (WO-2009094578-\$.did. or (US-20090205712-\$ or US-20080121279-\$ or WO-2007130188-\$ or US-7468485-\$ or JP-07106611-\$ or US-20040200520-\$ or JP-2004247364-\$ or US-5030295-\$ or WO-03083955-\$ or WO-2007082760-\$.did.				
S433	1	2007-797066.NRAN.	DERWENT	OR	ON	2017/06/26 15:03
S434	1	2007-797066.NRAN.	DERWENT	OR	ON	2017/06/26 15:09
S435	21	"8222516"	US-PGPUB; USPAT; FPRS; EPO; DERWENT	OR	ON	2017/06/26 15:27
S436	27	"8207444"	US-PGPUB; USPAT; FPRS; EPO; DERWENT	OR	ON	2017/06/26 15:28
S438	114	grad\$4 with index same (oxide "TiO.sub.2" silica SiO) and (solar photovoltaic).ab.	US-PGPUB; USPAT; FPRS; EPO; DERWENT	OR	ON	2017/06/26 16:39
S437	667	grad\$4 with index and (solar photovoltaic).ab.	US-PGPUB; USPAT; FPRS; EPO; DERWENT	OR	ON	2017/06/26 16:39
S439	1	"14504771"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2017/09/28 11:59
S440	692	polysilicon with surface near2 field	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO;	OR	ON	2017/09/28 14:44

			DERWENT; IBM_TDB			
S441	71	polysilicon with surface near2 field same (crystalline wafer monocrystalline crystal)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2017/09/28 14:45
S442	73	(polysilicon) with (surface near2 field BSF FSF) same (crystalline wafer monocrystalline crystal)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2017/09/28 14:47
S443	146	(polysilicon polycrystalline near2 silicon) with (surface near2 field BSF FSF) same (crystalline wafer monocrystalline crystal)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2017/09/28 14:48
S444	73	S443 not S442	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2017/09/28 14:49
S445	1	"14504771"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/03/01 18:41
S446	1	"14504771"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO;	OR	ON	2018/03/05 16:07

			DERWENT; IBM_TDB			
S447	83	(US-20050268963-\$ or US-20020153039-\$ or US-20060196535-\$ or US-20090101199-\$ or US-20040097062-\$ or US-20040112426-\$ or US-20070186970-\$ or US-20050272175-\$ or US-20040063326-\$ or US-20100224238-\$ or US-20100000597-\$ or US-20070256728-\$ or US-20060060238-\$ or US-20080092944-\$ or US-20110162706-\$ or US-20070151598-\$ or US-20080092951-\$ or US-20110104618-\$ or US-20080223446-\$ or US-20070151599-\$ or US-20090205712-\$ or US-20100186803-\$ or US-20090142880-\$ or US-20060255340-\$ or US-20050017257-\$ or US-20100186802-\$).did. or (US-20020142500-\$ or US-20040003836-\$ or US-20100087031-\$ or US-20090017606-\$ or US-20090183768-\$ or US-20110139231-\$).did. or (US-4379944-\$ or US-4665277-\$ or US-5320684-\$ or US-6210991-\$ or US-5792280-\$ or US-5899704-\$ or US-6262359-\$ or US-5258077-\$ or US-6071753-\$ or US-7468485-\$ or US-7838400-\$ or US-5641362-\$ or US-8222516-\$ or US-3961997-\$ or US-5057439-\$ or US-8207443-\$ or US-5138256-\$ or US-7633006-\$ or US-6130380-\$ or US-5738731-\$ or US-4927770-\$ or US-6624049-\$ or US-4152824-\$ or US-6214743-\$ or US-7029943-\$ or US-6998288-\$).did. or (US-8878053-\$ or US-8207444-\$ or US-5538564-\$ or US-7566974-\$ or US-5030295-\$ or US-6407012-\$ or US-5563092-\$ or US-7858430-\$ or US-7554031-\$ or US-5759292-\$ or US-6429037-\$ or US-6146483-\$).did. or (WO-2009094578-\$ or WO-2009094578-\$).did. or (WO-2009094578-\$).did. or (US-20090205712-\$ or US-20080121279-\$ or WO-2007130188-\$ or US-7468485-\$ or JP-07106611-\$ or US-20040200520-\$ or JP-2004247364-\$ or US-5030295-\$ or	US-PGPUB; USPAT; FPRS; EPO; DERWENT	OR	ON	2018/03/28 13:53

		WO-03083955-\$ or WO-2007082760-\$).did.				
S448	47	S447 and (Al aluminum) with (electrode contact)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/03/28 13:54
S449	10	"20060157103"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2020/05/26 16:56
S451	4	"20100037936"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2020/05/26 16:58
S450	3	"20090205712"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2020/05/26 16:58
S453	10	S452 and edge near2 isolation	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2020/05/26 16:59
S452	83	(US-20050268963-\$ or US-20020153039-\$ or US-20060196535-\$ or US-20090101199-\$ or US-20040097062-\$ or US-20040112426-\$ or US-20070186970-\$ or US-20050272175-\$ or US-20040063326-\$ or US-20100224238-	US-PGPUB; USPAT; FPRS; EPO; DERWENT	OR	ON	2020/05/26 16:59

		\$ or US-20100000597-\$ or US-20070256728-\$ or US-20060060238-\$ or US-20080092944-\$ or US-20110162706-\$ or US-20070151598-\$ or US-20080092951-\$ or US-20110104618-\$ or US-20080223446-\$ or US-20070151599-\$ or US-20090205712-\$ or US-20100186803-\$ or US-20090142880-\$ or US-20060255340-\$ or US-20050017257-\$ or US-20100186802-\$).did. or (US-20020142500-\$ or US-20040003836-\$ or US-20100087031-\$ or US-20090017606-\$ or US-20090183768-\$ or US-20110139231-\$).did. or (US-4379944-\$ or US-4665277-\$ or US-5320684-\$ or US-6210991-\$ or US-5792280-\$ or US-5899704-\$ or US-6262359-\$ or US-5258077-\$ or US-6071753-\$ or US-7468485-\$ or US-7838400-\$ or US-5641362-\$ or US-8222516-\$ or US-3961997-\$ or US-5057439-\$ or US-8207443-\$ or US-5138256-\$ or US-7633006-\$ or US-6130380-\$ or US-5738731-\$ or US-4927770-\$ or US-6624049-\$ or US-4152824-\$ or US-6214743-\$ or US-7029943-\$ or US-6998288-\$).did. or (US-8878053-\$ or US-8207444-\$ or US-5538564-\$ or US-7566974-\$ or US-5030295-\$ or US-6407012-\$ or US-5563092-\$ or US-7858430-\$ or US-7554031-\$ or US-5759292-\$ or US-6429037-\$ or US-6146483-\$).did. or (WO-2009094578-\$ or WO-2009094578-\$).did. or (WO-2009094578-\$).did. or (US-20090205712-\$ or US-20080121279-\$ or WO-2007130188-\$ or US-7468485-\$ or JP-07106611-\$ or US-20040200520-\$ or JP-2004247364-\$ or US-5030295-\$ or WO-03083955-\$ or WO-2007082760-\$).did.				
S454	14	"12166266"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO;	OR	ON	2020/05/26 17:01

			DERWENT; IBM_TDB			
S456	48	trench same edge with electric\$4 with isolation and (solar near2 (cell battery) photovoltaic)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2020/05/26 17:03
S455	0	"12166266" and trench.clm.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2020/05/26 17:03
S457	2257	(photovoltaic solar near2 (cell battery)) same (back rear) near contact and (busbar bus near bar)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2020/05/26 17:27
S459	633	(photovoltaic solar near2 (cell battery)) with (back rear) near contact and (busbar bus near bar) same interconnect\$4	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2020/05/26 17:28
S458	1925	(photovoltaic solar near2 (cell battery)) with (back rear) near contact and (busbar bus near bar)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2020/05/26 17:28
S462	1258	(photovoltaic solar near2 (cell battery)) and (busbar bus near bar) with (rear back) and (busbar bus near bar) with (front)	US-PGPUB; USPAT; USOCR	OR	ON	2020/05/26 17:32

S461	2145	(photovoltaic solar near2 (cell battery)) and (busbar bus near bar) with (rear back)	US-PGPUB; USPAT; USOCR	OR	ON	2020/05/26 17:32
S460	3398	(photovoltaic solar near2 (cell battery)) and (busbar bus near bar) with (rear back)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2020/05/26 17:32
S463	90	(photovoltaic solar near2 (cell battery)) and (busbar bus near bar) with (rear back) and (busbar bus near bar) with (front) and (front near surface near field FSF)	US-PGPUB; USPAT; USOCR	OR	ON	2020/05/26 17:34
S464	275	(photovoltaic solar near2 (cell battery)) and (busbar bus near bar) and (front near surface near field FSF)	US-PGPUB; USPAT; USOCR	OR	ON	2020/05/26 17:36
S465	185	S464 not S463	US-PGPUB; USPAT; USOCR	OR	ON	2020/05/26 17:37
S468	220	S467 not S464	US-PGPUB; USPAT; USOCR	OR	ON	2020/05/26 17:39
S467	314	(photovoltaic solar near2 (cell battery)) and (busbar bus near bar) and (back near junction)	US-PGPUB; USPAT; USOCR	OR	ON	2020/05/26 17:39
S466	1488	(photovoltaic solar near2 (cell battery)) and (busbar bus near bar) and (surface near field FSF)	US-PGPUB; USPAT; USOCR	OR	ON	2020/05/26 17:39
S470	80	S469 not S467	US-PGPUB; USPAT; USOCR	OR	ON	2020/05/26 17:42
S469	394	(photovoltaic solar near2 (cell battery)) and (busbar bus near bar) and ((back rear) near junction)	US-PGPUB; USPAT; USOCR	OR	ON	2020/05/26 17:42
L8	73	"4665277"	US-PGPUB; USPAT; USOCR;	OR	ON	2020/05/27 09:40

			FPRS; EPO; JPO; DERWENT; IBM_TDB			
L12	2	"20090301557"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2020/05/27 09:47
L13	1	"14686801"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2020/05/27 09:49
L14	14	("20100218821" "20100275983" "20130061924" "20090301557" "20100224251" "20120040490").PN.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2020/05/27 09:52
L15	3	"20040200520"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2020/05/27 10:00
L17	2	"20050189013"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2020/05/27 10:02
L16	3	"20050189015"	US-PGPUB; USPAT; USOCR; FPRS; EPO;	OR	ON	2020/05/27 10:02

			JPO; DERWENT; IBM_TDB			
L18	9	"6461947"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2020/05/27 10:03
L19	1119	point near contact with (rear back) and ("SiO.sub.2" silica passivat\$4)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2020/05/27 10:05
L20	191	point near contact with (rear back) and ("SiO.sub.2" silica passivat\$4) same (reflect\$4 mirror) and (photovoltaic solar near2 (Cell battery module panel) photoelectric photocell photo?cell).ab.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2020/05/27 10:06
L21	98	"7388147"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2020/05/27 10:29
L22	89	("20030160026" "4234352" "4478879" "4557037" "4920639" "4927770" "5053083" "5151168" "5310699" "6551931" "6638688").PN. OR ("7388147").URPN.	US-PGPUB; USPAT; USOCR	OR	ON	2020/05/27 10:30
L23	611	edge near isolation and (photovoltaic solar near2 (Cell battery module panel) photoelectric photocell photo?cell).ab.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO;	OR	ON	2020/05/27 11:54

			DERWENT; IBM_TDB			
L24	269	edge near isolation same (cut\$3 saw\$3 laser scribe) and (photovoltaic solar near2 (Cell battery module panel) photoelectric photocell photo?cell).ab.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2020/05/27 11:56
L25	67	"4726850"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2020/05/27 11:58
L26	16	"02103810"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2020/05/27 11:59
L27	8	"20080121266"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2020/05/27 12:31
L28	47	(H01L31/0236 H01L31/0745 H01L31/1804 H01L31/022425 H01L31/068 H01L31/182 H01L31/056).cpc. and (Y02E10/52 Y02P70/521 Y02E10/547).cpc. and (polysilicon polycrystalline) near emitter and tunnel\$3 near oxide	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2020/05/27 12:52

EAST Search History (Interference)

<This search history is empty>

5/27/2020 12:53:36 PM

C:\Users\dpillay\Documents\EAST\Workspaces\16460035.wsp

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

First Named Inventor:

Peter John COUSINS

Application No.: 16/460,035

Examiner: PILLAY, DEVINA

Filing Date: July 2, 2019

Art Unit: 1726

Title: FRONT CONTACT SOLAR CELL WITH FORMED EMITTER

RESPONSE TO OFFICE ACTION AND AMENDMENT

INTRODUCTORY COMMENTS

This submission is responsive to the office action mailed on July 6, 2020.

Please amend the above-identified application as follows.

AMENDMENTS TO THE CLAIMS

1-20 (canceled)

21. (Currently amended) A solar cell, the solar cell comprising:

a N-type silicon substrate having a front surface and a back surface, wherein the front surface comprises a textured surface;

an antireflective layer over the front surface of the N-type silicon substrate;

~~a doped region~~ a plurality of dot-shaped N-type doped regions in the front surface
of the N-type silicon substrate under the antireflective layer, each of the plurality of dot-
shaped doped regions having a dot shape as seen from a plan view of the solar cell;

an oxide region disposed on the back surface of the N-type silicon substrate;

a polysilicon emitter disposed on the oxide region;

a first metal contact disposed on the front surface of the N-type silicon substrate,
wherein the first metal contact is in electrical contact with the plurality of dot-shaped N-
type doped regions ~~region~~; and

a second metal contact disposed on the polysilicon emitter.

22. (Previously presented) The solar cell of claim 21, wherein the antireflective layer comprises a layer of silicon nitride.

23. (Previously presented) The solar cell of claim 21, wherein the polysilicon emitter comprises a P-type doped polysilicon.

24. (Previously presented) The solar cell of claim 21, further comprising a dielectric layer over the polysilicon emitter.

25. (Previously presented) The solar cell of claim 24, wherein the dielectric layer comprises silicon dioxide.

26. (Previously presented) The solar cell of claim 24, further comprising a trench cutting through the dielectric layer and the polysilicon emitter and into a portion of the N-type silicon substrate on the backside of the solar cell.

27. (Previously presented) The solar cell of claim 21, wherein the second metal contact comprises a metal forming an infrared reflecting layer with a dielectric layer.
28. (Previously presented) The solar cell of claim 21, wherein the second metal contact comprises a metal formed in a plurality of contact holes to the polysilicon emitter.
29. (Previously presented) The solar cell of claim 21, wherein the first and second metal contacts comprise a metal selected from the group consisting of silver or aluminum.
30. (Currently amended) A solar cell, the solar cell comprising:
a substrate having a front surface and a back surface, wherein the front surface comprises a textured surface;
an antireflective layer over the front surface of the substrate;
a ~~doped region~~ plurality of dot-shaped doped regions ~~in the front surface of the substrate~~ under the antireflective layer, each of the dot-shaped doped regions having a dot shape as seen from a plan view of the solar cell;
an oxide region disposed on the back surface of the substrate;
a polysilicon emitter disposed on the oxide region;
a first bus bar disposed on the front surface of the substrate;
a first metal contact disposed on the front surface of the substrate perpendicular to the first bus bar, wherein the first metal contact is in electrical contact with the plurality of dot-shaped doped regions, and perpendicular to, and the first bus bar; and
a second metal contact disposed on the polysilicon emitter.
31. (Previously presented) The solar cell of claim 30, further comprising a second bus bar disposed on the front surface of the substrate, wherein the second bus bar is parallel to the first bus bar.

32. (Previously presented) The solar cell of claim 31, wherein the first metal contact is in electrical contact with, and perpendicular to, the first bus bar and the second bus bar.
33. (Previously presented) The solar cell of claim 31, further comprising a third bus bar disposed on the back surface of the substrate.
34. (Previously presented) The solar cell of claim 33, further comprising a fourth bus bar disposed on the back surface of the substrate, wherein the fourth bus bar is parallel to the third bus bar.
35. (Previously presented) The solar cell of claim 31, wherein the polysilicon emitter comprises a P-type doped polysilicon.
36. (Currently amended) A solar cell array, the solar cell array comprising:
a first solar cell, the first solar cell comprising:
a substrate having a front surface and a back surface, wherein the front surface comprises a textured surface;
an antireflective layer over the front surface of the substrate;
a plurality of dot-shaped doped regions doped region in the front surface of the substrate under the antireflective layer, each of the plurality of dot-shaped doped regions having a dot shape as seen from a plan view of the first solar cell;
an oxide region disposed on the back surface of the substrate;
a polysilicon emitter disposed on the oxide region;
a first bus bar disposed on the front surface of the substrate, wherein the first bus bar is electrically connected to a corresponding bus bar of another solar cell;
a first metal contact disposed on the front surface of the N-type silicon substrate perpendicular to the first bus bar, wherein the first metal contact is in electrical contact with the plurality of dot-shaped doped regions, ~~and perpendicular to, the first bus bar~~; and
a second metal contact ~~[[,]]~~ disposed on the polysilicon emitter.

37. (Previously presented) The solar cell array of claim 36, further comprising a second bus bar disposed on the front surface of the first solar cell, wherein the second bus bar is parallel to the first bus bar.

38. (Previously presented) The solar cell of claim 37, wherein the first metal contact is in electrical contact with and perpendicular to the first bus bar and the second bus bar of the first solar cell.

39. (Previously presented) The solar cell of claim 37, further comprising a third bus bar disposed on the back surface of the first solar cell, wherein the third bus bar is electrically connected to a corresponding bus bar of another solar cell.

40. (Previously presented) The solar cell of claim 39, further comprising a fourth bus bar disposed on the back surface of the first solar cell, wherein the fourth bus bar is parallel to the third bus bar.

REMARKS

With the above amendments, claims 21-40 remain in the application.

Claim amendments have been made to expedite prosecution. Applicant expressly reserves the right to pursue the original version of an amended claim in a continuing application.

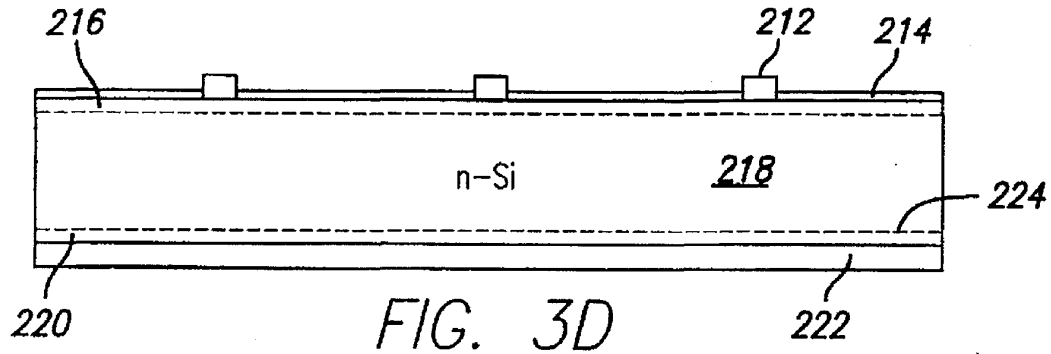
Claim Rejections -- 35 U.S.C. § 103

Claims 21-23 are rejected under pre-AIA 35 U.S.C. §103(a) as being unpatentable over Meier (US 6,262,359) in view of Okayasu (JP07-106611) in view of Borden (WO 2009/094578) in view of Wenham (US 6,429,037) in view of Jordan (US 2005/0268963). The rejection is respectfully traversed.

Claim 21 is patentable over the combination of Meier, Okayasu, Borden, Wenham, and Jordan at least for reciting: “a plurality of dot-shaped N-type doped regions in the N-type silicon substrate under the antireflective layer, each of the plurality of dot-shaped doped regions having a dot shape as seen from a plan view of the solar cell” and “a first metal contact disposed on the front surface of the N-type silicon substrate, wherein the first metal contact is in electrical contact with the plurality of dot-shaped N-type doped regions.”

During prosecution, pending claims are given their broadest reasonable interpretation consistent with the specification as interpreted by one of ordinary skill in the art. *In re Am. Acad. of Sci. Tech. Ctr.*, 367 F.3d 1359, 1364 (Fed. Cir. 2004). Here, in the embodiment of claim 21, a first metal contact on the front surface of the substrate is in electrical contact with a plurality of dot-shaped N-type doped regions. Support for this feature of claim 21 may be found at least on page 4, lines 17-19 and FIG. 2 (see 106) of the specification.

Meier FIG. 3D is reproduced below for ease of discussion.



Meier addresses a problem in the prior art where a heavily-doped emitter layer on the front is needed to avoid shunting of the PN junction of the solar cell (Meier, column 2, lines 13-25). Meier teaches moving the PN junction 224 near the back of the solar cell, instead of the front, to avoid the aforementioned shunting problem (Meier, column 5, lines 11-22). It is respectfully submitted, however, that Meier and the references of record in combination do not teach or suggest that the N-type layer 216 of Meier has or can be modified to have a dot shape.

Therefore, it is respectfully submitted that claim 21 is patentable over the references of record. Independent claims 30 and 36 are similarly patentable. The remaining claims are patentable at least for depending from patentable base claims.

Conclusion

It is believed that the present application is in condition for allowance. The Examiner is invited to telephone the undersigned for any questions and to resolve any remaining concerns regarding allowability of the present application.

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Respectfully submitted,

Dated: Sept. 24, 2020

Patrick D. Benedicto

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Tel.: (408)436-2112

Electronic Acknowledgement Receipt	
EFS ID:	40657278
Application Number:	16460035
International Application Number:	
Confirmation Number:	5633
Title of Invention:	FRONT CONTACT SOLAR CELL WITH FORMED EMITTER
First Named Inventor/Applicant Name:	Peter John COUSINS
Customer Number:	74254
Filer:	Patrick D. Benedicto/Jina Mangaoang
Filer Authorized By:	Patrick D. Benedicto
Attorney Docket Number:	10031.004212
Receipt Date:	24-SEP-2020
Filing Date:	02-JUL-2019
Time Stamp:	14:14:59
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment		no			
File Listing:					
Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1		S0123US_ROAmailed06Jul2020.pdf	461177 9810ae09bdf43ea4f0a9e07c4d5ff647374f3819	yes	8

Multipart Description/PDF files in .zip description			
Document Description		Start	End
Amendment/Req. Reconsideration-After Non-Final Reject		1	1
Claims		2	5
Applicant Arguments/Remarks Made in an Amendment		6	8

Warnings:

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If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371
If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office
If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

PATENT APPLICATION FEE DETERMINATION RECORD Substitute for Form PTO-875				Application or Docket Number 16/460,035		Filing Date 07/02/2019		☐ To be Mailed					
ENTITY: ☒ LARGE ☐ SMALL ☐ MICRO													
APPLICATION AS FILED - PART I													
		(Column 1)		(Column 2)									
FOR		NUMBER FILED		NUMBER EXTRA		RATE (\$)		FEE (\$)					
☐ BASIC FEE (37 CFR 1.16(a), (b), or (c))		N/A		N/A		N/A							
☐ SEARCH FEE (37 CFR 1.16(k), (l), or (m))		N/A		N/A		N/A							
☐ EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))		N/A		N/A		N/A							
TOTAL CLAIMS (37 CFR 1.16(i))		minus 20 =		*		x \$100 =							
INDEPENDENT CLAIMS (37 CFR 1.16(h))		minus 3 =		*		x \$460 =							
☐ APPLICATION SIZE FEE (37 CFR 1.16(s))		If the specification and drawings exceed 100 sheets of paper, the application size fee due is \$310 (\$155 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).											
☐ MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))													
* If the difference in column 1 is less than zero, enter "0" in column 2.						TOTAL							
APPLICATION AS AMENDED - PART II													
		(Column 1)		(Column 2)		(Column 3)							
AMENDMENT	09/24/2020	CLAIMS REMAINING AFTER AMENDMENT		HIGHEST NUMBER PREVIOUSLY PAID FOR		PRESENT EXTRA		RATE (\$)		ADDITIONAL FEE (\$)			
	Total (37 CFR 1.16(i))	* 20	Minus	** 20	= 0			x \$100 =		0			
	Independent (37 CFR 1.16(h))	* 3	Minus	*** 3	= 0			x \$460 =		0			
	☐ Application Size Fee (37 CFR 1.16(s))												
	☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))												
										TOTAL ADD'L FEE		0	
AMENDMENT			(Column 1)		(Column 2)		(Column 3)						
			CLAIMS REMAINING AFTER AMENDMENT		HIGHEST NUMBER PREVIOUSLY PAID FOR		PRESENT EXTRA		RATE (\$)		ADDITIONAL FEE (\$)		
			Total (37 CFR 1.16(i))	*	Minus	**			x \$0 =				
			Independent (37 CFR 1.16(h))	*	Minus	***			x \$0 =				
	☐ Application Size Fee (37 CFR 1.16(s))												
☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))													
										TOTAL ADD'L FEE			
* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.										SLIE			
** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20".										/ERIC A DANTZLER/			
*** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3".													
The "Highest Number Previously Paid For" (Total or Independent) is the highest number found in the appropriate box in column 1.													

This collection of information is required by 37 CFR 1.16. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
16/460,035	07/02/2019	Peter John COUSINS	10031.004212	5633
74254	7590	10/21/2020		
Okamoto & Benedicto LLP (SunPower)			EXAMINER	
P.O. Box 641330			PILLAY, DEVINA	
San Jose, CA 95164-1330				
			ART UNIT	PAPER NUMBER
			1726	
			MAIL DATE	DELIVERY MODE
			10/21/2020	PAPER

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Office Action Summary

Application No.
16/460,035

Applicant(s)
COUSINS, Peter John

Examiner
DEVINA PILLAY

Art Unit
1726

AIA (FITF) Status
No

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTHS FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1) ☒ Responsive to communication(s) filed on 09/24/2020.

☐ A declaration(s)/affidavit(s) under **37 CFR 1.130(b)** was/were filed on ____.

2a) ☒ This action is **FINAL**.

2b) ☐ This action is non-final.

3) ☐ An election was made by the applicant in response to a restriction requirement set forth during the interview on ____; the restriction requirement and election have been incorporated into this action.

4) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims*

5) ☒ Claim(s) 21-40 is/are pending in the application.

5a) Of the above claim(s) ____ is/are withdrawn from consideration.

6) ☐ Claim(s) ____ is/are allowed.

7) ☒ Claim(s) 21-40 is/are rejected.

8) ☐ Claim(s) ____ is/are objected to.

9) ☐ Claim(s) ____ are subject to restriction and/or election requirement

* If any claims have been determined allowable, you may be eligible to benefit from the **Patent Prosecution Highway** program at a participating intellectual property office for the corresponding application. For more information, please see http://www.uspto.gov/patents/init_events/pph/index.jsp or send an inquiry to PPHfeedback@uspto.gov.

Application Papers

10) ☐ The specification is objected to by the Examiner.

11) ☐ The drawing(s) filed on ____ is/are: a) ☐ accepted or b) ☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

Priority under 35 U.S.C. § 119

12) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

Certified copies:

a) ☐ All b) ☐ Some** c) ☐ None of the:

1. ☐ Certified copies of the priority documents have been received.

2. ☐ Certified copies of the priority documents have been received in Application No. ____.

3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

** See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)

3) ☐ Interview Summary (PTO-413)

Paper No(s)/Mail Date ____.

2) ☐ Information Disclosure Statement(s) (PTO/SB/08a and/or PTO/SB/08b)

4) ☐ Other: ____.

Paper No(s)/Mail Date ____.

DETAILED ACTION

Notice of Pre-AIA or AIA Status

The present application is being examined under the pre-AIA first to invent provisions.

Claim Rejections - 35 USC § 103

The text of those sections of Title 35, U.S. Code not included in this action can be found in a prior Office action.

Claims 21-23 is/are rejected under pre-AIA 35 U.S.C. 103(a) as being unpatentable over Meier (US 6,262,359) in view of Okayasu (JP07-106611, Human Translation) in view of Borden (WO 2009/094578 A2) and in view of Wenham (6,429,037 B1) in view of Jordan (US 2005/0268963 A1) in view of Xi (US 4,865,999).

Regarding claims 21 and 23, Meier discloses a solar cell comprising (see Fig. 3D, C5/L38-C6/L55):

a n-type silicon substrate (218 n-type, C5/L30-42) having a front surface that faces the sun to collect solar radiation during normal operation and a back surface opposite the front surface;

an anti-reflection (214) coating on the front surface of the solar cell;

an emitter (220 p-type) forming a backside junction with the substrate;

a front electrode disposed over the front surface of the substrate (212);

a back electrode disposed over the back surface of the substrate (222)

a front surface field region on the front surface (216 high doped concentration area n+), on the front surface of the substrate.

Meier discloses point style contacts but does not disclose that under the point contacts there is a highly doped region which are dot shaped.

Wenham discloses a solar cell wherein the area beneath point contacts includes areas of high doping which is important for reducing contact resistance (see Fig. 5, portions 18 and 23) (C1/L25-41).

It would have been obvious to one of ordinary skill in the art at the time of the invention to modify the front surface field formed in the substrate of modified Meier by adding in highly doped regions under the metallic contacts as disclosed by Wenham because doing so reduces the contact resistance and will improve the efficiency of the solar cell.

Modified Meier does not disclose that the point contacts are dot shaped.

Xi discloses that either point contacts or electrical contact dots can be used as electrical contacts for solar cells (C3/L40-45).

It would have been obvious to one of ordinary skill in the art at the time of the invention to modify the shape of the point contacts to have dot contact shape because as disclosed by Xi having a dot like point contact shape is known and one of ordinary skill in the art would have been able to carry out such a substitution, and the results would be reasonably predictable.

Note that the cross-sectional shape of the point contact of modified Meier will have the corresponding the plurality of dot-shaped doped regions having a dot shape as seen from a plan view of the solar cell.

However, Meier does not disclose that there is a textured surface on the N-type silicon substrate on the front side of the solar cell.

Jordan discloses that the front surface of the solar cell is textured ([0022]). In addition, Jordan discloses that texturizing the front surface increases light absorption ([0022]).

It would have been obvious to one of ordinary skill in the art at the time of the invention to modify the front surface of Meier by texturizing the front surface as disclosed by Jordan because it increases light adsorption.

However, Meier does not disclose that the emitter is a polysilicon emitter or that the front surface field is formed of polysilicon and that there is a tunnel dielectric formed between the emitter and the back surface of the substrate or that there is a tunnel dielectric formed between the front surface field and the substrate.

Okayasu discloses that instead of forming an emitter **or** surface field from a portion of a substrate which is doped, an emitter or surface field can be formed using a doped polysilicon layer ([0005] [0009], Abstract) and by forming an emitter or surface field this way the thickness can be more accurately controlled and it prevents generation of floating foreign matter ([0008] [0009]).

It would have been obvious to one of ordinary skill in the art at the time of the invention to replace the method of forming the emitter/front surface field from a portion of a substrate of Meier and instead forming the emitter and front surface field by using a doped polysilicon layer as disclosed by Okayasu because the thickness can be more accurately controlled and it prevent generation of floating foreign matter.

However, modified Meier does not discloses a tunneling dielectric oxide between the emitter/front surface field and the substrate.

Borden discloses that tunnel oxides can be used in solar cells between doped polysilicon and monocrystalline substrates [0016] and can be formed on both the front and back surfaces of a monocrystalline substrate.

Furthermore, Borden discloses that by providing the tunneling layer it prevents epitaxial growth of the emitter layer and further it protects the surface from plasma damage of the deposited emitter layer [0015].

It would have been obvious to one of ordinary skill in the art at the time of the invention to modify the interface between polycrystalline layers and monocrystalline substrate back and front surfaces of modified Meier by having a tunneling oxide at the interfaces because it prevents epitaxial growth of the emitter layer and further it protects the crystalline surface from plasma damage of the deposited emitter layer.

Modified Meier discloses a first tunnel dielectric between the emitter and back surface and a second tunnel dielectric at the front surface of the substrate.

Modified Meier now discloses a p-type polysilicon emitter and an n+-type polysilicon FSF.

Regarding claim 22, modified Meier discloses all of the claim limitations as set forth above.

In addition Meier discloses that the antireflective layer comprises silicon nitride (C6/L20-25).

Claims 24, 25, and 27-29 is/are rejected under pre-AIA 35 U.S.C. 103(a) as being unpatentable over Meier (US 6,262,359) in view of Okayasu (JP07-106611, Human Translation) in view of Borden (WO 2009/094578 A2) and in further view of Wenham (6,429,037 B1) in view of Jordan (US 2005/0268963 A1) in view of Xi (US

4,865,999) as applied to claims 21-23 above and in further view of Agnostinelli (US 2009/0301557 A1).

Regarding claim 24, 25, 27, 28, modified Meier discloses all of the claim limitations as set forth above.

However, Meier does not disclose a dielectric over a polysilicon emitter.

Agnostinelli discloses a back contact structure which comprises a dielectric/passivation layer structure formed on the back surface of the solar cell which is patterned and back contacts touch the rear doped surface of the solar cell and a continuous back contact layer is formed over the dielectric (SiO₂ [0116])/passivation stack ([0049][0048][0116]).

It would have been obvious to one of ordinary skill at the time of the invention to modify the solar cell of Meier by having a dielectric/passivation layer structure formed on the back surface of the solar cell which is patterned and back contacts touch the rear doped surface of the solar cell and a continuous back contact layer is formed over the dielectric as disclosed Agnostinelli because it will improve the reflection and absorption of light by the solar cell and furthermore improve the passivation of the rear surface.

Regarding claim 29, modified Meier discloses all of the claim limitations as set forth above.

Meier discloses that the front contact can be silver (212, C7/L10-15).

However, Meier does not disclose that the electrode that is in contact with the p-type polysilicon layer is silver.

Okayasu discloses that the back electrode on the polysilicon emitter is formed of a silver electrode [0044].

It would have been obvious to one of ordinary skill in the art at the time of the invention to replace the aluminum electrode of Meier with the silver electrode of Okayasu because one of ordinary skill in the art would have been able to carry out such a substitution, and the results would be reasonably predictable.

Claim 26 is/are rejected under pre-AIA 35 U.S.C. 103(a) as being unpatentable over Meier (US 6,262,359) in view of Okayasu (JP07-106611, Human Translation) in view of Borden (WO 2009/094578 A2) and in further view of Wenham (6,429,037 B1) in view of Jordan (US 2005/0268963 A1)) in view of Xi (US 4,865,999) in view of Agnostinelli (US 2009/0301557 A1) as applied to claims 24, 25, and 27-29 above and in further view of Russell (US 2008/0216893 A1) and in view of Kray (Study on the edge isolation of industrial silicon solar cells with waterjet-guided laser).

Regarding claim 26, modified Meier discloses all of the claim limitations as set forth above.

However, modified Meier does not disclose trench cutting through the dielectric layer and the polysilicon emitter and into a portion of the n-type silicon substrate on the back side of the substrate.

Russell discloses that edge isolations can be performed at different positions on the solar cell including back sides and serve to electrically isolate the front and rear solar cells from each other ([0042]).

Kray discloses an edge isolation process which includes cutting through the passivation layer, doped layer and part of the substrate (See Fig. 1).

It would have been obvious to one of ordinary skill in the art at the time of the invention to modify the solar cell of modified Meier by having the edge be isolated by cutting through the rear passivation layer, rear emitter layer and part of the substrate as disclosed by Russell and Kray because it will prevent a shunt between front and back surfaces.

Claims 30-40 is/are rejected under pre-AIA 35 U.S.C. 103(a) as being unpatentable over Meier (US 6,262,359) in view of Okayasu (JP07-106611, Human Translation) in view of Borden (WO 2009/094578 A2) and in view of Wenham (6,429,037 B1) in view of Xi (US 4,865,999) in view of Jordan (US 2005/0268963 A1) in view of Tsunomura (US 2008/0121266 A1).

Regarding claims 30-35, Meier discloses a solar cell comprising (see Fig. 3D, C5/L38-C6/L55):

a n-type silicon substrate (218 n-type, C5/L30-42) having a front surface that faces the sun to collect solar radiation during normal operation and a back surface opposite the front surface;

an anti-reflection (214) coating on the front surface of the solar cell;

an emitter (220 p-type) forming a backside junction with the substrate;

a front electrode disposed over the front surface of the substrate (212);

a back electrode disposed over the back surface of the substrate (222)

a front surface field region on the front surface (216 high doped concentration area n+), on the front surface of the substrate.

Meier discloses point style contacts but does not disclose that under the point contacts there is a highly doped region n-type region which are dot shaped.

Wenham discloses a solar cell wherein the area beneath point contacts includes areas of high doping which is important for reducing contact resistance (see Fig. 5, portions 18 and 23) (C1/L25-41).

It would have been obvious to one of ordinary skill in the art at the time of the invention to modify the front surface field formed in the substrate of modified Meier by adding in highly doped regions under the metallic contacts as disclosed by Wenham because doing so reduces the contact resistance and will improve the efficiency of the solar cell.

Modified Meier does not disclose that the point contacts are dot shaped.

Xi discloses that either point contacts or electrical contact dots can be used as electrical contacts for solar cells (C3/L40-45).

It would have been obvious to one of ordinary skill in the art at the time of the invention to modify the shape of the point contacts to have dot contact shape because as disclosed by Xi having a dot like point contact shape is known and one of ordinary skill in the art would have been able to carry out such a substitution, and the results would be reasonably predictable.

Note that the cross-sectional shape of the point contact of modified Meier will have the corresponding the plurality of dot-shaped doped regions having a dot shape as seen from a plan view of the solar cell.

However, Meier does not disclose that there is a textured surface on the N-type silicon substrate on the front side of the solar cell.

Jordan discloses that the front surface of the solar cell is textured ([0022]). In addition, Jordan discloses that texturizing the front surface increases light absorption ([0022]).

It would have been obvious to one of ordinary skill in the art at the time of the invention to modify the front surface of Meier by texturizing the front surface as disclosed by Jordan because it increases light adsorption.

However, Meier does not disclose that the emitter is a polysilicon emitter or that the front surface field is formed of polysilicon and that there is a tunnel dielectric formed between the emitter and the back surface of the substrate or that there is a tunnel dielectric formed between the front surface field and the substrate.

Okayasu discloses that instead of forming an emitter **or** surface field from a portion of a substrate which is doped, an emitter or surface field can be formed using a doped polysilicon layer ([0005] [0009], Abstract) and by forming an emitter or surface field this way the thickness can be more accurately controlled and it prevents generation of floating foreign matter ([0008] [0009]).

It would have been obvious to one of ordinary skill in the art at the time of the invention to replace the method of forming the emitter/front surface field from a portion of a substrate of Meier and instead forming the emitter and front surface field by using a doped polysilicon layer as disclosed by Okayasu because the thickness can be more accurately controlled and it prevent generation of floating foreign matter.

However, modified Meier does not discloses a tunneling dielectric oxide between the emitter/front surface field and the substrate.

Borden discloses that tunnel oxides can be used in solar cells between doped polysilicon and monocrystalline substrates [0016] and can be formed on both the front and back surfaces of a monocrystalline substrate.

Furthermore, Borden discloses that by providing the tunneling layer it prevents epitaxial growth of the emitter layer and further it protects the surface from plasma damage of the deposited emitter layer [0015].

It would have been obvious to one of ordinary skill in the art at the time of the invention to modify the interface between polycrystalline layers and monocrystalline substrate back and front surfaces of modified Meier by having a tunneling oxide at the interfaces because it prevents epitaxial growth of the emitter layer and further it protects the crystalline surface from plasma damage of the deposited emitter layer.

Modified Meier discloses a first tunnel dielectric between the emitter and back surface and a second tunnel dielectric at the front surface of the substrate.

Modified Meier now discloses a p-type polysilicon emitter and an n+-type polysilicon FSF.

However, modified Meier does not disclose two bus bars on the front which run perpendicular to electrodes and two bus bars on the rear of the cell.

Tsunomura discloses two bus bars on the front (20) which run perpendicular to electrodes (30) and two bus bars on the rear of the cell (20) (see Figs. 2 and 3) ([0029][0030]).

It would have been obvious to one of ordinary skill in the art at the time of the invention to modify the solar cell of Meier so that there bus bars as disclosed by

Tsunomura because it will improve the collection of photogenerated carriers because there are additional contacts and conductivity of the electrode.

Regarding claims 36-40, Meier discloses a solar cell comprising (see Fig. 3D, C5/L38-C6/L55):

- a n-type silicon substrate (218 n-type, C5/L30-42) having a front surface that faces the sun to collect solar radiation during normal operation and a back surface opposite the front surface;

- an anti-reflection (214) coating on the front surface of the solar cell;

- an emitter (220 p-type) forming a backside junction with the substrate;

- a front electrode disposed over the front surface of the substrate (212);

- a back electrode disposed over the back surface of the substrate (222)

- a front surface field region on the front surface (216 high doped concentration area n+), on the front surface of the substrate.

Meier discloses point style contacts but does not disclose that under the point contacts there is a highly doped region n-type region which are dot shaped.

Wenham discloses a solar cell wherein the area beneath point contacts includes areas of high doping which is important for reducing contact resistance (see Fig. 5, portions 18 and 23) (C1/L25-41).

It would have been obvious to one of ordinary skill in the art at the time of the invention to modify the front surface field formed in the substrate of modified Meier by adding in highly doped regions under the metallic contacts as disclosed by Wenham because doing so reduces the contact resistance and will improve the efficiency of the solar cell.

Modified Meier does not disclose that the point contacts are dot shaped.

Xi discloses that either point contacts or electrical contact dots can be used as electrical contacts for solar cells (C3/L40-45).

It would have been obvious to one of ordinary skill in the art at the time of the invention to modify the shape of the point contacts to have dot contact shape because as disclosed by Xi having a dot like point contact shape is known and one of ordinary skill in the art would have been able to carry out such a substitution, and the results would be reasonably predictable.

Note that the cross-sectional shape of the point contact of modified Meier will have the corresponding the plurality of dot-shaped doped regions having a dot shape as seen from a plan view of the solar cell.

However, Meier does not disclose that there is a textured surface on the N-type silicon substrate on the front side of the solar cell.

Jordan discloses that the front surface of the solar cell is textured ([0022]). In addition, Jordan discloses that texturizing the front surface increases light absorption ([0022]).

It would have been obvious to one of ordinary skill in the art at the time of the invention to modify the front surface of Meier by texturizing the front surface as disclosed by Jordan because it increases light adsorption.

However, Meier does not disclose that the emitter is a polysilicon emitter or that the front surface field is formed of polysilicon and that there is a tunnel dielectric formed between the emitter and the back surface of the substrate or that there is a tunnel dielectric formed between the front surface field and the substrate.

Okayasu discloses that instead of forming an emitter **or** surface field from a portion of a substrate which is doped, an emitter or surface field can be formed using a doped polysilicon layer ([0005] [0009], Abstract) and by forming an emitter or surface field this way the thickness can be more accurately controlled and it prevents generation of floating foreign matter ([0008] [0009]).

It would have been obvious to one of ordinary skill in the art at the time of the invention to replace the method of forming the emitter/front surface field from a portion of a substrate of Meier and instead forming the emitter and front surface field by using a doped polysilicon layer as disclosed by Okayasu because the thickness can be more accurately controlled and it prevent generation of floating foreign matter.

However, modified Meier does not discloses a tunneling dielectric oxide between the emitter/front surface field and the substrate.

Borden discloses that tunnel oxides can be used in solar cells between doped polysilicon and monocrystalline substrates [0016] and can be formed on both the front and back surfaces of a monocrystalline substrate.

Furthermore, Borden discloses that by providing the tunneling layer it prevents epitaxial growth of the emitter layer and further it protects the surface from plasma damage of the deposited emitter layer [0015].

It would have been obvious to one of ordinary skill in the art at the time of the invention to modify the interface between polycrystalline layers and monocrystalline substrate back and front surfaces of modified Meier by having a tunneling oxide at the interfaces because it prevents epitaxial growth of the emitter layer and further it protects the crystalline surface from plasma damage of the deposited emitter layer.

Modified Meier discloses a first tunnel dielectric between the emitter and back surface and a second tunnel dielectric at the front surface of the substrate.

Modified Meier now discloses a p-type polysilicon emitter and an n+-type polysilicon FSF.

However, modified Meier does not disclose two bus bars on the front which run perpendicular to electrodes and two bus bars on the rear of the cell.

Tsunomura discloses two bus bars on the front (20) which run perpendicular to electrodes (30) and two bus bars on the rear of the cell (20) (see Figs. 2 and 3) ([0029][0030]).

It would have been obvious to one of ordinary skill in the art at the time of the invention to modify the solar cell of Meier so that there bus bars as disclosed by Tsunomura because it will improve the collection of photogenerated carriers because there are additional contacts and conductivity of the electrode.

However, modified Meier does not disclose that the solar cell is part of an array of cells and they are interconnected.

Tsunomura discloses an array of solar cells that interconnected by attaching wiring to the bus bars on the back and front of solar cells (see Fig. 1, interconnect 40 and Fig. 4 [0016]).

It would have been obvious to one of ordinary skill in the art at the time of invention to modify the solar cell of modified Meier by including additional solar cells to form an array of solar cells and interconnecting them as disclosed by Tsunomura because doing so will harness more solar energy.

Response to Arguments

Applicant argues that the prior art does not disclose a plurality of dot-shaped N-type doped regions in the N-type silicon substrate under the antireflective layer, each of the plurality of dot-shaped doped regions having a dot shape as seen from a plan view of the solar cell" and "a first metal contact disposed on the front surface of the N-type silicon substrate, wherein the first metal contact is in electrical contact with the plurality of dot-shaped N-type doped regions.

Examiner respectfully disagrees. The combination of Wenham and Xi disclose the above feature as noted in the above rejection.

Conclusion

Applicant's amendment necessitated the new ground(s) of rejection presented in this Office action. Accordingly, **THIS ACTION IS MADE FINAL**. See MPEP § 706.07(a). Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the date of this final action.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to DEVINA PILLAY whose telephone number is (571)270-1180. The examiner can normally be reached on Monday-Friday 9:30-6:00.

Examiner interviews are available via telephone, in-person, and video conferencing using a USPTO supplied web-based collaboration tool. To schedule an interview, applicant is encouraged to use the USPTO Automated Interview Request (AIR) at <http://www.uspto.gov/interviewpractice>.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Jeffrey T Barton can be reached on 517-272-1307. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <https://ppair-my.uspto.gov/pair/PrivatePair>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

/DEVINA PILLAY/
Primary Examiner, Art Unit 1726

<i>Notice of References Cited</i>	Application/Control No. 16/460,035		Applicant(s)/Patent Under Reexamination COUSINS, Peter John	
	Examiner DEVINA PILLAY		Art Unit 1726	Page 1 of 1

U.S. PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Name	CPC Classification	US Classification
*	A	US-4865999-A	09-1989	Xi; Jianping	H01L31/022425	438/83
	B					
	C					
	D					
	E					
	F					
	G					
	H					
	I					
	J					
	K					
	L					
	M					

FOREIGN PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Country	Name	CPC Classification
	N					
	O					
	P					
	Q					
	R					
	S					
	T					

NON-PATENT DOCUMENTS

*		Include as applicable: Author, Title Date, Publisher, Edition or Volume, Pertinent Pages)
	U	
	V	
	W	
	X	

*A copy of this reference is not being furnished with this Office action. (See MPEP § 707.05(a).)
Dates in MM-YYYY format are publication dates. Classifications may be US or foreign.

Search Notes 	Application/Control No. 16/460,035	Applicant(s)/Patent Under Reexamination COUSINS, Peter John
	Examiner DEVINA PILLAY	Art Unit 1726

CPC - Searched*		
Symbol	Date	Examiner
H01L31/0236 H01L31/0745 H01L31/1804 H01L31/022425 H01L31/068 H01L31/182 H01L31/056; text limited	05/27/2020	DP
Updated CPC text limited search	10/05/2020	

CPC Combination Sets - Searched*		
Symbol	Date	Examiner

US Classification - Searched*			
Class	Subclass	Date	Examiner

* See search history printout included with this form or the SEARCH NOTES box below to determine the scope of the search.

Search Notes		
Search Notes	Date	Examiner
Inventor name search in EAST	05/27/2020	DP
EAST Text Search (See Search History)	05/27/2020	DP
Updated EAST Text Search (See Search History)	10/05/2020	DP

Interference Search			
US Class/CPC Symbol	US Subclass/CPC Group	Date	Examiner

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EAST Search History

EAST Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
S491	52	(point) near5 contact with (dot) and H01L31\$.cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2020/10/05 13:35
S493	1,299	(point) near5 contact and (circle dot spherical) and H01L31\$.cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2020/10/05 13:36
S492	4,568	(point) near5 contact and H01L31\$.cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2020/10/05 13:36
S495	92	(point) near5 contact with (circle dot spherical) and H01L31\$.cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2020/10/05 13:37
S494	196	(point) near5 contact same (circle dot spherical) and H01L31\$.cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2020/10/05 13:37
L1	50	(H01L31/0236 H01L31/0745 H01L31/1804 H01L31/022425 H01L31/068 H01L31/182 H01L31/056).cpc. and (Y02E10/52 Y02P70/521 Y02E10/547).cpc. and (polysilicon polycrystalline) near emitter and tunnel\$3 near oxide	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2020/10/05 17:53

EAST Search History (Interference)

<This search history is empty>

10/5/2020 6:04:21 PM

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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

First Named Inventor:

Peter John COUSINS

Application No.: 16/460,035

Examiner: PILLAY, DEVINA

Filing Date: July 2, 2019

Art Unit: 1726

Assignee: SunPower Corporation

Title: FRONT CONTACT SOLAR CELL WITH FORMED EMITTER

APPEAL BRIEF FILED UNDER 37 C.F.R. § 41.37

This Appeal Brief is submitted with a Notice of Appeal.

I. REAL PARTY IN INTEREST

The real party in interest is the SunPower Corporation, which is the assignee of the present application.

II. RELATED APPEALS AND INTERFERENCES

On information and belief, there are no appeals, interferences, or judicial proceedings known to the appellant, the appellant's legal representative, or assignee which may be related to, directly affect or be directly affected by or have a bearing on the Patent Trial and Appeal Board decision in the pending appeal.

III. SUMMARY OF CLAIMED SUBJECT MATTER

Claim 21 recites a solar cell that includes an N-type silicon substrate (specification, page 4, lines 7-9; FIG. 1, 101) having a front surface and a back surface, wherein the front surface comprises a textured surface (specification, page 4, lines 12-14; FIG. 1, 113). An antireflective layer is over the front surface of the N-type silicon substrate (specification, page 4, lines 22 and 23; FIG. 1, 103). Dot-shaped N-type doped regions are in the N-type silicon substrate under the antireflective layer, each of the dot-shaped doped regions having a dot shape as seen from a plan view of the solar cell (specification, page 4, lines 17-19; FIG. 1, 106; FIG. 2, 106). An oxide region is disposed on the back surface of the N-type silicon substrate (specification, page 5, lines 4 and 5; FIG. 1, 107). A polysilicon emitter is disposed on the oxide region (specification, page 5, lines 4 and 5; FIG. 1, 108). A first metal contact is disposed on the front surface of the N-type silicon substrate, wherein the first metal contact is in electrical contact with the dot-shaped N-type doped regions (specification, page 5, lines 19-21; FIG. 1, 102; FIG. 2, 102). A second metal contact is disposed on the polysilicon emitter (specification, page 5, lines 10-12; FIG. 1, 110).

Claim 30 recites a solar cell that includes a substrate (specification, page 4, lines 7-9; FIG. 1, 101) having a front surface and a back surface, wherein the front surface comprises a textured surface (specification, page 4, lines 12-14; FIG. 1, 113). An antireflective layer is over the front surface of the substrate (specification, page 4, lines 22 and 23; FIG. 1, 103). Dot-shaped N-type doped regions are in the N-type silicon substrate under the antireflective layer, each of the dot-shaped doped regions having a dot shape as seen from a plan view of the solar cell (specification, page 4, lines 17-19; FIG. 1, 106; FIG. 2, 106). An oxide region is disposed on the back surface of the substrate (specification, page 5, lines 4 and 5; FIG. 1, 107). A polysilicon emitter is disposed on the oxide region (specification, page 5, lines 4 and 5; FIG. 1, 108). A first bus bar is disposed on the front surface of the substrate (specification, page 6, lines 7-9; FIG. 2, 201). A first metal contact is disposed on the front surface of the substrate perpendicular to the first bus bar (specification, page 6, lines 10-12; FIG. 2, 102), wherein the first metal contact is in electrical contact with the dot-shaped doped regions and the first bus bar (specification, page 5, lines 19-21; FIG. 1, 102; FIG. 2, 102). A second metal contact is disposed on the polysilicon emitter (specification, page 5, lines 10-12; FIG. 1, 110).

Claim 36 recites a solar cell array that includes a first solar cell (specification, page 6, lines 15-17). The first solar cell includes a substrate (specification, page 4, lines 7-9; FIG. 1, 101) having a front surface and a back surface, wherein the front surface comprises a textured surface (specification, page 4, lines 12-14; FIG. 1, 113). An antireflective layer is over the front surface of the substrate (specification, page 4, lines 22 and 23; FIG. 1, 103). Dot-shaped doped regions are in the substrate under the antireflective layer, each of the dot-shaped doped regions having a dot shape as seen from a plan view of the first solar cell (specification, page 4, lines 17-19; FIG. 1, 106; FIG. 2, 106). An oxide region is disposed on the back surface of the substrate (specification, page 5, lines 4 and 5; FIG. 1, 107). A polysilicon emitter is disposed on the oxide region (specification, page 5, lines 4 and 5; FIG. 1, 108). A first bus bar is disposed on the front surface of the substrate (specification, page 6, lines 7-9; FIG. 2, 201), wherein the first bus bar is electrically connected to a corresponding bus bar of another solar cell (specification, page 6, lines 15-17). A first metal contact is disposed on the front surface of the N-type silicon substrate perpendicular to the first bus bar (specification, page 6, lines 10-12; FIG. 2, 102), wherein the first metal contact is in electrical contact with the dot-shaped doped regions (specification, page 5, lines 19-21; FIG. 1, 102; FIG. 2, 102). A second metal contact is disposed on the polysilicon emitter (specification, page 5, lines 10-12; FIG. 1, 110).

IV. ARGUMENT

Appellant traverses the rejections in the Final Office Action mailed on October 21, 2020 (“final office action”) for the following reasons.

A. CLAIMS 21-40

Claims 21-23 are rejected under pre-AIA 35 U.S.C. §103(a) as being unpatentable over Meier (US 6,262,359) in view of Okayasu (JP07-106611), Borden (WO 2009/094578), Wenham (US 6,429,037), Jordan (US 2005/0268963), and Xi (US 4,865,999). The rejection is respectfully traversed.

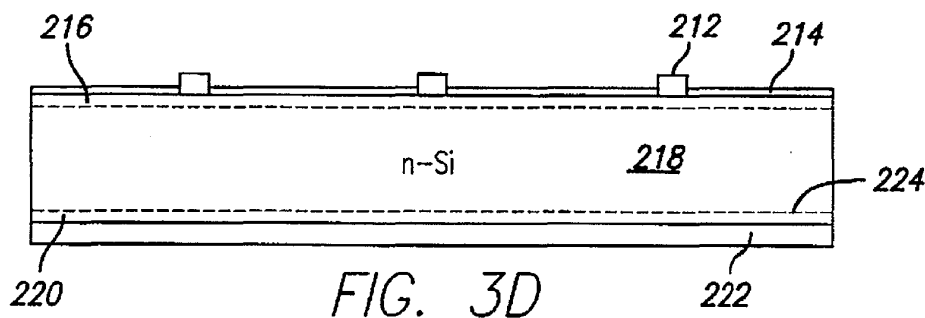
There are three requirements to establish a prima facie case of obviousness. First, there must be some suggestion or motivation to modify a reference or to combine

references. Second, there must be a reasonable expectation of success. Third, the prior art reference or combined references must teach or suggest all the claim limitations. See MPEP § 2143. As will be explained fully below, the references of record do not teach or suggest the recited dot-shaped doped regions.

Claim 21 is patentable over the combination of Meier, Okayasu, Borden, Wenham, Jordan, and Xi least for reciting: “a plurality of dot-shaped N-type doped regions in the N-type silicon substrate under the antireflective layer, each of the plurality of dot-shaped doped regions having a dot shape as seen from a plan view of the solar cell” and “a first metal contact disposed on the front surface of the N-type silicon substrate, wherein the first metal contact is in electrical contact with the plurality of dot-shaped N-type doped regions.”

During prosecution, pending claims are given their broadest reasonable interpretation consistent with the specification as interpreted by one of ordinary skill in the art. *In re Am. Acad. of Sci. Tech. Ctr.*, 367 F.3d 1359, 1364 (Fed. Cir. 2004). Here, in the embodiment of claim 21, a first metal contact on the front surface of the substrate is in electrical contact with a plurality of dot-shaped N-type doped regions. Support for this feature of claim 21 may be found at least on page 4, lines 17-19 and FIG. 2 (see 106) of the specification.

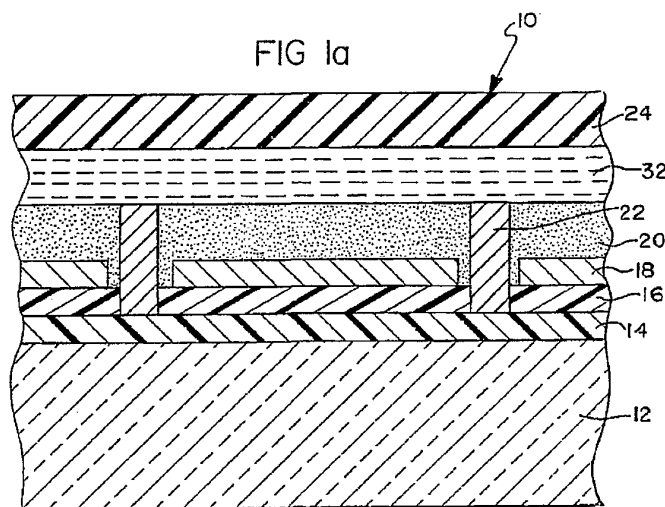
Meier FIG. 3D is reproduced below for ease of discussion.



Meier addresses a problem in the prior art where a heavily-doped emitter layer on the front is needed to avoid shunting of the PN junction of the solar cell (Meier, column 2, lines 13-25). Meier teaches moving the PN junction 224 near the back of the solar cell,

instead of the front, to avoid the aforementioned shunting problem (Meier, column 5, lines 11-22). It is respectfully submitted, however, that Meier and the references of record in combination do not teach or suggest that the N-type layer 216 of Meier has or can be modified to have a dot shape.

The final office action suggests that in the combination of Meier, Okayasu, Borden, Wenham, Jordan, and Xi, Xi teaches the recited dot-shaped N-type doped regions. Appellant respectfully disagrees. Xi FIG. 1a is reproduced below for ease of discussion.



Xi discloses a solar cell with point contacts 22 (Xi, column 3, lines 40-46), which the final office action suggests correspond to the recited dot-shaped doped regions. As is evident from Xi, the point contacts 22 are *contacts*, not doped regions of the solar cell. Doped regions and contacts that electrically connect to the doped regions are different structures of a solar cell. Xi does not teach or suggest that the TCO layer 14, which is electrically connected to the point contacts 22, is dot-shaped. In marked contrast, claim 21 recites a first metal contact that is in electrical contact with the plurality of *dot-shaped N-type doped regions*. It is respectfully submitted that Xi and the references of record do not disclose dot-shaped doped regions as recited.

The final office action suggests “that the cross-sectional shape of the point contact of modified Meier will have the corresponding plurality of dot-shaped doped regions

having a dot shape as seen from a plan view of the solar cell” (final office action, page 3, lines 19-21). Appellant respectfully disagrees.

It is respectfully submitted that there is no support for the conclusion that a doped-region will necessarily have the same shape as its contact. There is no reason why a point contact cannot be used to connect to planar regions. For example, Xi does not teach or suggest that the TCO layer 14 that is electrically connected to the point contacts 22 is dot-shaped. That is, modifying Meier to have point contacts as taught by Xi will result in the modified Meier having point contacts connected to the N-type layer 216 of Meier. The modified Meier will still have the same N-type layer 216, which is not an N-type dot-shaped doped region as recited.

It is respectfully submitted that Okayasu, Borden, Wenham, and Jordan do not add to Meier and Xi regarding the recited dot-shaped doped regions.

Therefore, it is respectfully submitted that claim 21 is patentable over the combination of Meier, Okayasu, Borden, Wenham, Jordan, and Xi.

Claims 22 and 23 are patentable over the combination of Meier, Okayasu, Borden, Wenham, Jordan, and Xi at least for depending from claim 21.

Claims 24, 25, and 27-29 are rejected under pre-AIA 35 U.S.C. §103(a) as being unpatentable over Meier (US 6,262,359) in view of Okayasu (JP07-106611), Borden (WO 2009/094578), Wenham (US 6,429,037), Jordan (US 2005/0268963), Xi (US 4,865,999), and Agnostinelli (US 2009/0301557). The rejection is respectfully traversed.

Claims 24, 25, and 27-29 are patentable over the combination of Meier, Okayasu, Borden, Wenham, Jordan, and Agnostinelli at least for depending from claim 21.

Claim 26 is rejected under pre-AIA 35 U.S.C. §103(a) as being unpatentable over Meier (US 6,262,359) in view of Okayasu (JP07-106611), Borden (WO 2009/094578), Wenham (US 6,429,037), Jordan (US 2005/0268963), Xi (US 4,865,999), Agnostinelli (US 2009/0301557), Russell (US 2008/0216893), and Kray (Study on the Edge Isolation of Industrial Silicon Solar Cells With Waterjet-Guided Laser).

Claim 26 is patentable over the combination of Meier, Okayasu, Borden, Wenham, Jordan, Xi, Agnostinelli, Russell, and Kray at least for depending from claim 21.

Claims 30-40 are rejected under pre-AIA 35 U.S.C. §103(a) as being unpatentable over Meier (US 6,262,359) in view of Okayasu (JP07-106611), Borden (WO 2009/094578), Wenham (US 6,429,037), Jordan (US 2005/0268963), Xi (US 4,865,999), and Tsunomura (US 2008/0121266). The rejection is respectfully traversed.

Claim 30 is patentable over the combination of Meier, Okayasu, Borden, Wenham, Jordan, Xi, and Tsunomura at least for reciting: “a plurality of dot-shaped doped regions in the substrate under the antireflective layer, each of the dot-shaped doped regions having a dot shape as seen from a plan view of the solar cell” and “a first metal contact disposed on the front surface of the substrate perpendicular to the first bus bar, wherein the first metal contact is in electrical contact with the plurality of dot-shaped doped regions and the first bus bar.”

As explained above, the combination of Meier, Okayasu, Borden, Wenham, Jordan, and Xi does not teach or suggest the recited plurality of dot-shaped doped regions that are connected to a metal contact. It is respectfully submitted that Tsunomura does not add to the combination of Meier, Okayasu, Borden, Wenham, Jordan, and Xi regarding the recited dot-shaped doped regions that are connected to the metal contact.

Therefore, it is respectfully submitted that claim 30 is patentable over the combination of Meier, Okayasu, Borden, Wenham, Jordan, Xi, and Tsunomura.

Claims 31-35 are patentable over the combination of Meier, Okayasu, Borden, Wenham, Jordan, Xi, and Tsunomura at least for depending from claim 30.

Claim 36 is patentable over the combination of Meier, Okayasu, Borden, Wenham, Jordan, Xi, and Tsunomura at least for reciting: “a plurality of dot-shaped doped regions in the substrate under the antireflective layer, each of the plurality of dot-shaped doped regions having a dot shape as seen from a plan view of the first solar cell” and “a first metal contact disposed on the front surface of the N-type silicon substrate perpendicular to the first bus bar, wherein the first metal contact is in electrical contact with the plurality of dot-shaped doped regions.”

As explained above, the combination of Meier, Okayasu, Borden, Wenham, Jordan, and Xi does not teach or suggest the recited plurality of dot-shaped doped regions that are connected to a metal contact. It is respectfully submitted that Tsunomura does not add to the combination of Meier, Okayasu, Borden, Wenham, Jordan, and Xi regarding the recited dot-shaped doped regions that are connected to the metal contact.

Therefore, it is respectfully submitted that claim 36 is patentable over the combination of Meier, Okayasu, Borden, Wenham, Jordan, Xi, and Tsunomura.

Claims 37-40 are patentable over the combination of Meier, Okayasu, Borden, Wenham, Jordan, Xi, and Tsunomura at least for depending from claim 36.

V. CONCLUSION

For at least the above reasons, allowance of the application is respectfully requested.

Respectfully submitted,

Dated: DEC. 1, 2020

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CLAIMS APPENDIX

CLAIMS INVOLVED IN THE APPEAL

21. A solar cell, the solar cell comprising:
a N-type silicon substrate having a front surface and a back surface, wherein the front surface comprises a textured surface;
an antireflective layer over the front surface of the N-type silicon substrate;
a plurality of dot-shaped N-type doped regions in the N-type silicon substrate under the antireflective layer, each of the plurality of dot-shaped doped regions having a dot shape as seen from a plan view of the solar cell;
an oxide region disposed on the back surface of the N-type silicon substrate;
a polysilicon emitter disposed on the oxide region;
a first metal contact disposed on the front surface of the N-type silicon substrate, wherein the first metal contact is in electrical contact with the plurality of dot-shaped N-type doped regions; and
a second metal contact disposed on the polysilicon emitter.
22. The solar cell of claim 21, wherein the antireflective layer comprises a layer of silicon nitride.
23. The solar cell of claim 21, wherein the polysilicon emitter comprises a P-type doped polysilicon.
24. The solar cell of claim 21, further comprising a dielectric layer over the polysilicon emitter.
25. The solar cell of claim 24, wherein the dielectric layer comprises silicon dioxide.
26. The solar cell of claim 24, further comprising a trench cutting through the dielectric layer and the polysilicon emitter and into a portion of the N-type silicon substrate on the backside of the solar cell.

27. The solar cell of claim 21, wherein the second metal contact comprises a metal forming an infrared reflecting layer with a dielectric layer.
28. The solar cell of claim 21, wherein the second metal contact comprises a metal formed in a plurality of contact holes to the polysilicon emitter.
29. The solar cell of claim 21, wherein the first and second metal contacts comprise a metal selected from the group consisting of silver or aluminum.
30. A solar cell, the solar cell comprising:
a substrate having a front surface and a back surface, wherein the front surface comprises a textured surface;
an antireflective layer over the front surface of the substrate;
a plurality of dot-shaped doped regions in the substrate under the antireflective layer, each of the dot-shaped doped regions having a dot shape as seen from a plan view of the solar cell;
an oxide region disposed on the back surface of the substrate;
a polysilicon emitter disposed on the oxide region;
a first bus bar disposed on the front surface of the substrate;
a first metal contact disposed on the front surface of the substrate perpendicular to the first bus bar, wherein the first metal contact is in electrical contact with the plurality of dot-shaped doped regions and the first bus bar; and
a second metal contact disposed on the polysilicon emitter.
31. The solar cell of claim 30, further comprising a second bus bar disposed on the front surface of the substrate, wherein the second bus bar is parallel to the first bus bar.
32. The solar cell of claim 31, wherein the first metal contact is in electrical contact with, and perpendicular to, the first bus bar and the second bus bar.

33. The solar cell of claim 31, further comprising a third bus bar disposed on the back surface of the substrate.

34. The solar cell of claim 33, further comprising a fourth bus bar disposed on the back surface of the substrate, wherein the fourth bus bar is parallel to the third bus bar.

35. The solar cell of claim 31, wherein the polysilicon emitter comprises a P-type doped polysilicon.

36. A solar cell array, the solar cell array comprising:
a first solar cell, the first solar cell comprising:
a substrate having a front surface and a back surface, wherein the front surface comprises a textured surface;
an antireflective layer over the front surface of the substrate;
a plurality of dot-shaped doped regions in the substrate under the antireflective layer, each of the plurality of dot-shaped doped regions having a dot shape as seen from a plan view of the first solar cell;
an oxide region disposed on the back surface of the substrate;
a polysilicon emitter disposed on the oxide region;
a first bus bar disposed on the front surface of the substrate, wherein the first bus bar is electrically connected to a corresponding bus bar of another solar cell;
a first metal contact disposed on the front surface of the N-type silicon substrate perpendicular to the first bus bar, wherein the first metal contact is in electrical contact with the plurality of dot-shaped doped regions; and
a second metal contact disposed on the polysilicon emitter.

37. The solar cell array of claim 36, further comprising a second bus bar disposed on the front surface of the first solar cell, wherein the second bus bar is parallel to the first bus bar.

38. The solar cell of claim 37, wherein the first metal contact is in electrical contact with and perpendicular to the first bus bar and the second bus bar of the first solar cell.

39. The solar cell of claim 37, further comprising a third bus bar disposed on the back surface of the first solar cell, wherein the third bus bar is electrically connected to a corresponding bus bar of another solar cell.

40. The solar cell of claim 39, further comprising a fourth bus bar disposed on the back surface of the first solar cell, wherein the fourth bus bar is parallel to the third bus bar.

Electronic Patent Application Fee Transmittal				
Application Number:		16460035		
Filing Date:		02-Jul-2019		
Title of Invention:		FRONT CONTACT SOLAR CELL WITH FORMED EMITTER		
First Named Inventor/Applicant Name:		Peter John COUSINS		
Filer:		Patrick D. Benedicto/Jina Mangaoang		
Attorney Docket Number:		10031.004212		
Filed as Large Entity				
Filing Fees for Utility under 35 USC 111(a)				
Description	Fee Code	Quantity	Amount	Sub-Total in USD(\$)
Basic Filing:				
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				
NOTICE OF APPEAL	1401	1	840	840
Post-Allowance-and-Post-Issuance:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD(\$)
Extension-of-Time:				
Miscellaneous:				
Total in USD (\$)				840

Electronic Acknowledgement Receipt	
EFS ID:	41261085
Application Number:	16460035
International Application Number:	
Confirmation Number:	5633
Title of Invention:	FRONT CONTACT SOLAR CELL WITH FORMED EMITTER
First Named Inventor/Applicant Name:	Peter John COUSINS
Customer Number:	74254
Filer:	Patrick D. Benedicto/Jina Mangaoang
Filer Authorized By:	Patrick D. Benedicto
Attorney Docket Number:	10031.004212
Receipt Date:	01-DEC-2020
Filing Date:	02-JUL-2019
Time Stamp:	14:41:43
Application Type:	Utility under 35 USC 111(a)

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Submitted with Payment	yes
Payment Type	CARD
Payment was successfully received in RAM	\$840
RAM confirmation Number	E2020B1E42001257
Deposit Account	
Authorized User	

The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows:

File Listing:					
Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Notice of Appeal Filed	S0123US3_NoticeOfAppeal.pdf	99066	no	1
			5242c57e8da51a709fa0645860837e6d18c06a0		
Warnings:					
Information:					
2	Appeal Brief Filed	S0123US3_AppealBrief.pdf	967334	no	12
			6b61ab442ca6ea13ce9343ba4ff141b6269d4cbd		
Warnings:					
Information:					
3	Fee Worksheet (SB06)	fee-info.pdf	30530	no	2
			455941c2c37737fa9b4e6cc64f0fa1d64c88ed80		
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Total Files Size (in bytes):			1096930		
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NOTICE OF APPEAL FROM THE EXAMINER TO THE PATENT TRIAL AND APPEAL BOARD		Docket Number (Optional) 10031.004212
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Signature <u>/Patrick D. Benedicto/</u>		
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BEFORE THE PATENT TRIAL AND APPEAL BOARD

Application Number: 16/460,035
Filing Date: 2 Jul 2019
Appellant(s): COUSINS, Peter, John

Patrick D. Benedicto
For Appellant

EXAMINER'S ANSWER

This is in response to the appeal brief filed 12/01/2020.

(1) Grounds of Rejection to be Reviewed on Appeal

Every ground of rejection set forth in the Office action dated 10/21/2020 from which the appeal is taken is being maintained by the examiner except for the grounds of rejection (if any) listed under the subheading "WITHDRAWN REJECTIONS." New grounds of rejection (if any) are provided under the subheading "NEW GROUNDS OF REJECTION."

The following ground(s) of rejection are applicable to the appealed claims.

Claims 21-23 is/are rejected under pre-AIA 35 U.S.C. 103(a) as being unpatentable over Meier (US 6,262,359) in view of Okayasu (JP07-106611, Human Translation) in view of Borden (WO 2009/094578 A2) and in view of Wenham (6,429,037 B1) in view of Jordan (US 2005/0268963 A1) in view of Xi (US 4,865,999).

Regarding claims 21 and 23, Meier discloses a solar cell comprising (see Fig. 3D, C5/L38-C6/L55):

a n-type silicon substrate (218 n-type, C5/L30-42) having a front surface that faces the sun to collect solar radiation during normal operation and a back surface opposite the front surface;

an anti-reflection (214) coating on the front surface of the solar cell;

an emitter (220 p-type) forming a backside junction with the substrate;

a front electrode disposed over the front surface of the substrate (212);

a back electrode disposed over the back surface of the substrate (222)

a front surface field region on the front surface (216 high doped concentration area n+), on the front surface of the substrate.

Meier discloses point style contacts but does not disclose that under the point contacts there is a highly doped region which are dot shaped.

Wenham discloses a solar cell wherein the area beneath point contacts includes areas of high doping which is important for reducing contact resistance (see Fig. 5, portions 18 and 23) (C1/L25-41).

It would have been obvious to one of ordinary skill in the art at the time of the invention to modify the front surface field formed in the substrate of modified Meier by adding in highly doped regions under the metallic contacts as disclosed by Wenham because doing so reduces the contact resistance and will improve the efficiency of the solar cell.

Modified Meier does not disclose that the point contacts are dot shaped.

Xi discloses that either point contacts or electrical contact dots can be used as electrical contacts for solar cells (C3/L40-45).

It would have been obvious to one of ordinary skill in the art at the time of the invention to modify the shape of the point contacts to have dot contact shape because as disclosed by Xi having a dot like point contact shape is known and one of ordinary skill in the art would have been able to carry out such a substitution, and the results would be reasonably predictable.

Note that the cross-sectional shape of the point contact of modified Meier will have the corresponding the plurality of dot-shaped doped regions having a dot shape as seen from a plan view of the solar cell.

However, Meier does not disclose that there is a textured surface on the N-type silicon substrate on the front side of the solar cell.

Jordan discloses that the front surface of the solar cell is textured ([0022]). In addition, Jordan discloses that texturizing the front surface increases light absorption ([0022]).

It would have been obvious to one of ordinary skill in the art at the time of the invention to modify the front surface of Meier by texturizing the front surface as disclosed by Jordan because it increases light adsorption.

However, Meier does not disclose that the emitter is a polysilicon emitter or that the front surface field is formed of polysilicon and that there is a tunnel dielectric formed between the emitter and the back surface of the substrate or that there is a tunnel dielectric formed between the front surface field and the substrate.

Okayasu discloses that instead of forming an emitter **or** surface field from a portion of a substrate which is doped, an emitter or surface field can be formed using a doped polysilicon layer ([0005] [0009], Abstract) and by forming an emitter or surface field this way the thickness can be more accurately controlled and it prevents generation of floating foreign matter ([0008] [0009]).

It would have been obvious to one of ordinary skill in the art at the time of the invention to replace the method of forming the emitter/front surface field from a portion of a substrate of Meier and instead forming the emitter and front surface field by using a doped polysilicon layer as disclosed by Okayasu because the thickness can be more accurately controlled and it prevent generation of floating foreign matter.

However, modified Meier does not discloses a tunneling dielectric oxide between the emitter/front surface field and the substrate.

Borden discloses that tunnel oxides can be used in solar cells between doped polysilicon and monocrystalline substrates [0016] and can be formed on both the front and back surfaces of a monocrystalline substrate.

Furthermore, Borden discloses that by providing the tunneling layer it prevents epitaxial growth of the emitter layer and further it protects the surface from plasma damage of the deposited emitter layer [0015].

It would have been obvious to one of ordinary skill in the art at the time of the invention to modify the interface between polycrystalline layers and monocrystalline substrate back and front surfaces of modified Meier by having a tunneling oxide at the interfaces because it prevents epitaxial growth of the emitter layer and further it protects the crystalline surface from plasma damage of the deposited emitter layer.

Modified Meier discloses a first tunnel dielectric between the emitter and back surface and a second tunnel dielectric at the front surface of the substrate.

Modified Meier now discloses a p-type polysilicon emitter and an n+-type polysilicon FSF.

Regarding claim 22, modified Meier discloses all of the claim limitations as set forth above.

In addition Meier discloses that the antireflective layer comprises silicon nitride (C6/L20-25).

Claims 24, 25, and 27-29 is/are rejected under pre-AIA 35 U.S.C. 103(a) as being unpatentable over Meier (US 6,262,359) in view of Okayasu (JP07-106611, Human Translation) in view of Borden (WO 2009/094578 A2) and in further view of Wenham (6,429,037 B1) in view of Jordan (US 2005/0268963 A1) in view of Xi (US

4,865,999) as applied to claims 21-23 above and in further view of Agnostinelli (US 2009/0301557 A1).

Regarding claim 24, 25, 27, 28, modified Meier discloses all of the claim limitations as set forth above.

However, Meier does not disclose a dielectric over a polysilicon emitter.

Agnostinelli discloses a back contact structure which comprises a dielectric/passivation layer structure formed on the back surface of the solar cell which is patterned and back contacts touch the rear doped surface of the solar cell and a continuous back contact layer is formed over the dielectric (SiO₂ [0116])/passivation stack ([0049][0048][0116]).

It would have been obvious to one of ordinary skill at the time of the invention to modify the solar cell of Meier by having a dielectric/passivation layer structure formed on the back surface of the solar cell which is patterned and back contacts touch the rear doped surface of the solar cell and a continuous back contact layer is formed over the dielectric as disclosed Agnostinelli because it will improve the reflection and absorption of light by the solar cell and furthermore improve the passivation of the rear surface.

Regarding claim 29, modified Meier discloses all of the claim limitations as set forth above.

Meier discloses that the front contact can be silver (212, C7/L10-15).

However, Meier does not disclose that the electrode that is in contact with the p-type polysilicon layer is silver.

Okayasu discloses that the back electrode on the polysilicon emitter is formed of a silver electrode [0044].

It would have been obvious to one of ordinary skill in the art at the time of the invention to replace the aluminum electrode of Meier with the silver electrode of Okayasu because one of ordinary skill in the art would have been able to carry out such a substitution, and the results would be reasonably predictable.

Claim 26 is/are rejected under pre-AIA 35 U.S.C. 103(a) as being unpatentable over Meier (US 6,262,359) in view of Okayasu (JP07-106611, Human Translation) in view of Borden (WO 2009/094578 A2) and in further view of Wenham (6,429,037 B1) in view of Jordan (US 2005/0268963 A1)) in view of Xi (US 4,865,999) in view of Agnostinelli (US 2009/0301557 A1) as applied to claims 24, 25, and 27-29 above and in further view of Russell (US 2008/0216893 A1) and in view of Kray (Study on the edge isolation of industrial silicon solar cells with waterjet-guided laser).

Regarding claim 26, modified Meier discloses all of the claim limitations as set forth above.

However, modified Meier does not disclose trench cutting through the dielectric layer and the polysilicon emitter and into a portion of the n-type silicon substrate on the back side of the substrate.

Russell discloses that edge isolations can be performed at different positions on the solar cell including back sides and serve to electrically isolate the front and rear solar cells from each other ([0042]).

Kray discloses an edge isolation process which includes cutting through the passivation layer, doped layer and part of the substrate (See Fig. 1).

It would have been obvious to one of ordinary skill in the art at the time of the invention to modify the solar cell of modified Meier by having the edge be isolated by cutting through the rear passivation layer, rear emitter layer and part of the substrate as disclosed by Russell and Kray because it will prevent a shunt between front and back surfaces.

Claims 30-40 is/are rejected under pre-AIA 35 U.S.C. 103(a) as being unpatentable over Meier (US 6,262,359) in view of Okayasu (JP07-106611, Human Translation) in view of Borden (WO 2009/094578 A2) and in view of Wenham (6,429,037 B1) in view of Xi (US 4,865,999) in view of Jordan (US 2005/0268963 A1) in view of Tsunomura (US 2008/0121266 A1).

Regarding claims 30-35, Meier discloses a solar cell comprising (see Fig. 3D, C5/L38-C6/L55):

a n-type silicon substrate (218 n-type, C5/L30-42) having a front surface that faces the sun to collect solar radiation during normal operation and a back surface opposite the front surface;

an anti-reflection (214) coating on the front surface of the solar cell;

an emitter (220 p-type) forming a backside junction with the substrate;

a front electrode disposed over the front surface of the substrate (212);

a back electrode disposed over the back surface of the substrate (222)

a front surface field region on the front surface (216 high doped concentration area n+), on the front surface of the substrate.

Meier discloses point style contacts but does not disclose that under the point contacts there is a highly doped region n-type region which are dot shaped.

Wenham discloses a solar cell wherein the area beneath point contacts includes areas of high doping which is important for reducing contact resistance (see Fig. 5, portions 18 and 23) (C1/L25-41).

It would have been obvious to one of ordinary skill in the art at the time of the invention to modify the front surface field formed in the substrate of modified Meier by adding in highly doped regions under the metallic contacts as disclosed by Wenham because doing so reduces the contact resistance and will improve the efficiency of the solar cell.

Modified Meier does not disclose that the point contacts are dot shaped.

Xi discloses that either point contacts or electrical contact dots can be used as electrical contacts for solar cells (C3/L40-45).

It would have been obvious to one of ordinary skill in the art at the time of the invention to modify the shape of the point contacts to have dot contact shape because as disclosed by Xi having a dot like point contact shape is known and one of ordinary skill in the art would have been able to carry out such a substitution, and the results would be reasonably predictable.

Note that the cross-sectional shape of the point contact of modified Meier will have the corresponding the plurality of dot-shaped doped regions having a dot shape as seen from a plan view of the solar cell.

However, Meier does not disclose that there is a textured surface on the N-type silicon substrate on the front side of the solar cell.

Jordan discloses that the front surface of the solar cell is textured ([0022]). In addition, Jordan discloses that texturizing the front surface increases light absorption ([0022]).

It would have been obvious to one of ordinary skill in the art at the time of the invention to modify the front surface of Meier by texturizing the front surface as disclosed by Jordan because it increases light adsorption.

However, Meier does not disclose that the emitter is a polysilicon emitter or that the front surface field is formed of polysilicon and that there is a tunnel dielectric formed between the emitter and the back surface of the substrate or that there is a tunnel dielectric formed between the front surface field and the substrate.

Okayasu discloses that instead of forming an emitter **or** surface field from a portion of a substrate which is doped, an emitter or surface field can be formed using a doped polysilicon layer ([0005] [0009], Abstract) and by forming an emitter or surface field this way the thickness can be more accurately controlled and it prevents generation of floating foreign matter ([0008] [0009]).

It would have been obvious to one of ordinary skill in the art at the time of the invention to replace the method of forming the emitter/front surface field from a portion of a substrate of Meier and instead forming the emitter and front surface field by using a doped polysilicon layer as disclosed by Okayasu because the thickness can be more accurately controlled and it prevent generation of floating foreign matter.

However, modified Meier does not discloses a tunneling dielectric oxide between the emitter/front surface field and the substrate.

Borden discloses that tunnel oxides can be used in solar cells between doped polysilicon and monocrystalline substrates [0016] and can be formed on both the front and back surfaces of a monocrystalline substrate.

Furthermore, Borden discloses that by providing the tunneling layer it prevents epitaxial growth of the emitter layer and further it protects the surface from plasma damage of the deposited emitter layer [0015].

It would have been obvious to one of ordinary skill in the art at the time of the invention to modify the interface between polycrystalline layers and monocrystalline substrate back and front surfaces of modified Meier by having a tunneling oxide at the interfaces because it prevents epitaxial growth of the emitter layer and further it protects the crystalline surface from plasma damage of the deposited emitter layer.

Modified Meier discloses a first tunnel dielectric between the emitter and back surface and a second tunnel dielectric at the front surface of the substrate.

Modified Meier now discloses a p-type polysilicon emitter and an n+-type polysilicon FSF.

However, modified Meier does not disclose two bus bars on the front which run perpendicular to electrodes and two bus bars on the rear of the cell.

Tsunomura discloses two bus bars on the front (20) which run perpendicular to electrodes (30) and two bus bars on the rear of the cell (20) (see Figs. 2 and 3) ([0029][0030]).

It would have been obvious to one of ordinary skill in the art at the time of the invention to modify the solar cell of Meier so that there bus bars as disclosed by

Tsunomura because it will improve the collection of photogenerated carriers because there are additional contacts and conductivity of the electrode.

Regarding claims 36-40, Meier discloses a solar cell comprising (see Fig. 3D, C5/L38-C6/L55):

- a n-type silicon substrate (218 n-type, C5/L30-42) having a front surface that faces the sun to collect solar radiation during normal operation and a back surface opposite the front surface;

- an anti-reflection (214) coating on the front surface of the solar cell;

- an emitter (220 p-type) forming a backside junction with the substrate;

- a front electrode disposed over the front surface of the substrate (212);

- a back electrode disposed over the back surface of the substrate (222)

- a front surface field region on the front surface (216 high doped concentration area n+), on the front surface of the substrate.

Meier discloses point style contacts but does not disclose that under the point contacts there is a highly doped region n-type region which are dot shaped.

Wenham discloses a solar cell wherein the area beneath point contacts includes areas of high doping which is important for reducing contact resistance (see Fig. 5, portions 18 and 23) (C1/L25-41).

It would have been obvious to one of ordinary skill in the art at the time of the invention to modify the front surface field formed in the substrate of modified Meier by adding in highly doped regions under the metallic contacts as disclosed by Wenham because doing so reduces the contact resistance and will improve the efficiency of the solar cell.

Modified Meier does not disclose that the point contacts are dot shaped.

Xi discloses that either point contacts or electrical contact dots can be used as electrical contacts for solar cells (C3/L40-45).

It would have been obvious to one of ordinary skill in the art at the time of the invention to modify the shape of the point contacts to have dot contact shape because as disclosed by Xi having a dot like point contact shape is known and one of ordinary skill in the art would have been able to carry out such a substitution, and the results would be reasonably predictable.

Note that the cross-sectional shape of the point contact of modified Meier will have the corresponding the plurality of dot-shaped doped regions having a dot shape as seen from a plan view of the solar cell.

However, Meier does not disclose that there is a textured surface on the N-type silicon substrate on the front side of the solar cell.

Jordan discloses that the front surface of the solar cell is textured ([0022]). In addition, Jordan discloses that texturizing the front surface increases light absorption ([0022]).

It would have been obvious to one of ordinary skill in the art at the time of the invention to modify the front surface of Meier by texturizing the front surface as disclosed by Jordan because it increases light adsorption.

However, Meier does not disclose that the emitter is a polysilicon emitter or that the front surface field is formed of polysilicon and that there is a tunnel dielectric formed between the emitter and the back surface of the substrate or that there is a tunnel dielectric formed between the front surface field and the substrate.

Okayasu discloses that instead of forming an emitter **or** surface field from a portion of a substrate which is doped, an emitter or surface field can be formed using a doped polysilicon layer ([0005] [0009], Abstract) and by forming an emitter or surface field this way the thickness can be more accurately controlled and it prevents generation of floating foreign matter ([0008] [0009]).

It would have been obvious to one of ordinary skill in the art at the time of the invention to replace the method of forming the emitter/front surface field from a portion of a substrate of Meier and instead forming the emitter and front surface field by using a doped polysilicon layer as disclosed by Okayasu because the thickness can be more accurately controlled and it prevent generation of floating foreign matter.

However, modified Meier does not discloses a tunneling dielectric oxide between the emitter/front surface field and the substrate.

Borden discloses that tunnel oxides can be used in solar cells between doped polysilicon and monocrystalline substrates [0016] and can be formed on both the front and back surfaces of a monocrystalline substrate.

Furthermore, Borden discloses that by providing the tunneling layer it prevents epitaxial growth of the emitter layer and further it protects the surface from plasma damage of the deposited emitter layer [0015].

It would have been obvious to one of ordinary skill in the art at the time of the invention to modify the interface between polycrystalline layers and monocrystalline substrate back and front surfaces of modified Meier by having a tunneling oxide at the interfaces because it prevents epitaxial growth of the emitter layer and further it protects the crystalline surface from plasma damage of the deposited emitter layer.

Modified Meier discloses a first tunnel dielectric between the emitter and back surface and a second tunnel dielectric at the front surface of the substrate.

Modified Meier now discloses a p-type polysilicon emitter and an n+-type polysilicon FSF.

However, modified Meier does not disclose two bus bars on the front which run perpendicular to electrodes and two bus bars on the rear of the cell.

Tsunomura discloses two bus bars on the front (20) which run perpendicular to electrodes (30) and two bus bars on the rear of the cell (20) (see Figs. 2 and 3) ([0029][0030]).

It would have been obvious to one of ordinary skill in the art at the time of the invention to modify the solar cell of Meier so that there bus bars as disclosed by Tsunomura because it will improve the collection of photogenerated carriers because there are additional contacts and conductivity of the electrode.

However, modified Meier does not disclose that the solar cell is part of an array of cells and they are interconnected.

Tsunomura discloses an array of solar cells that interconnected by attaching wiring to the bus bars on the back and front of solar cells (see Fig. 1, interconnect 40 and Fig. 4 [0016]).

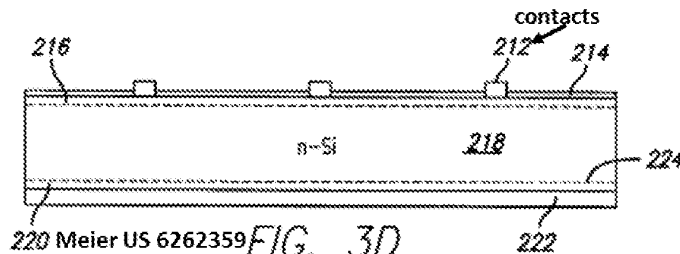
It would have been obvious to one of ordinary skill in the art at the time of invention to modify the solar cell of modified Meier by including additional solar cells to form an array of solar cells and interconnecting them as disclosed by Tsunomura because doing so will harness more solar energy.

(2) Response to Argument

Regarding claim 21, Appellant argues that Xi discloses a solar cell with point contacts 22 (Xi, column 3, lines 40-46), which the final office action suggests correspond to the recited dot-shaped doped regions and that the point contacts 22 are contacts, not doped regions of the solar cell. Doped regions and contacts that electrically connect to the doped regions are different structures of a solar cell. Applicant argues that Xi does not teach or suggest that the TCO layer 14, which is electrically connected to the point contacts 22, is dot-shaped, and that this differs from instant claim 21, which recites a first metal contact that is in electrical contact with the plurality of dot-shaped N-type doped regions. Applicant argues that that Xi and the references of record do not disclose dot-shaped doped regions as recited.

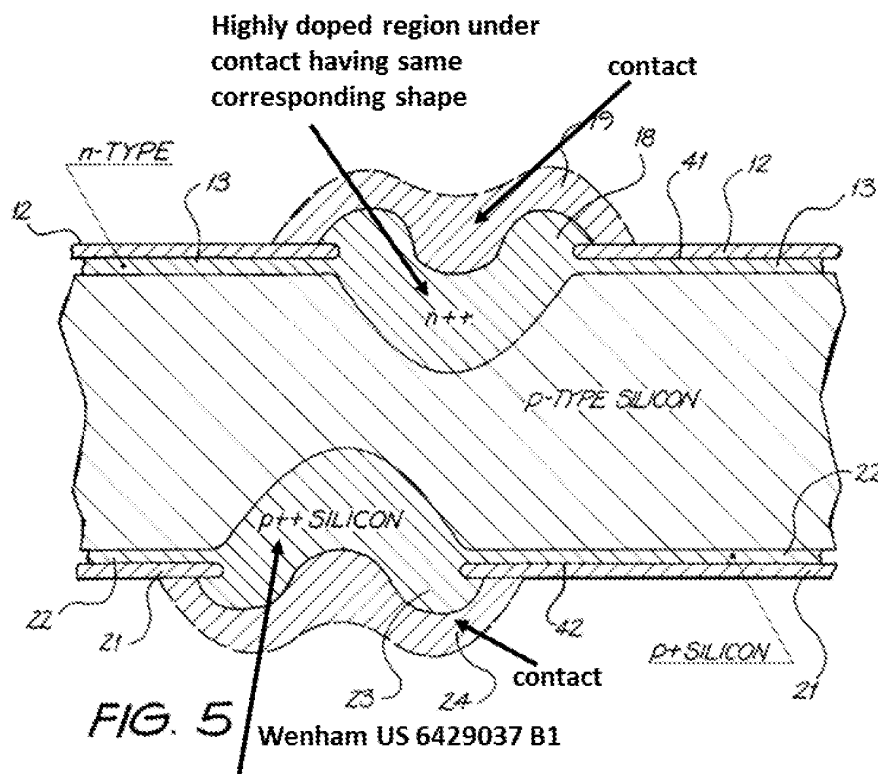
While Examiner does agree that doped regions and contacts that electrically connect to the doped regions are different structures of a solar cell, Examiner disagrees that Xi was solely used to teach both the doped regions and contacts as alleged by Appellant.

Examiner notes that Wenham was used to modify Meier to provide a plurality of N-type regions. As noted in the rejection, Meier discloses metal contacts (front electrode contacts, 212, please see Figure below, C7/L28-29), however, Meier does not disclose that under each of the contacts there exists a highly doped N-type dot shaped region.



Wenham discloses a solar cell wherein the areas (see Fig. 5, portions 18 and 23) beneath contacts (see Fig. 5, below, contacts 19 and 24) are highly doped, and providing these highly doped areas under contacts reduces contact resistance (C1/L25-41).

Wenham further discloses (see Figs. 1-3) that the areas of high doping beneath the contacts have shapes which correspond to the shape of the contacts because the high doped regions localized regions (15) are formed by patterning the plating mask (see mask 12, Fig. 2, C4/L20-40), and the localized regions (15) are subsequently plated with metal (19 see Fig. 3) to form contact (see area 18 of Fig. 3, which corresponds to where metal contact (19) is placed, C4/L20-40).

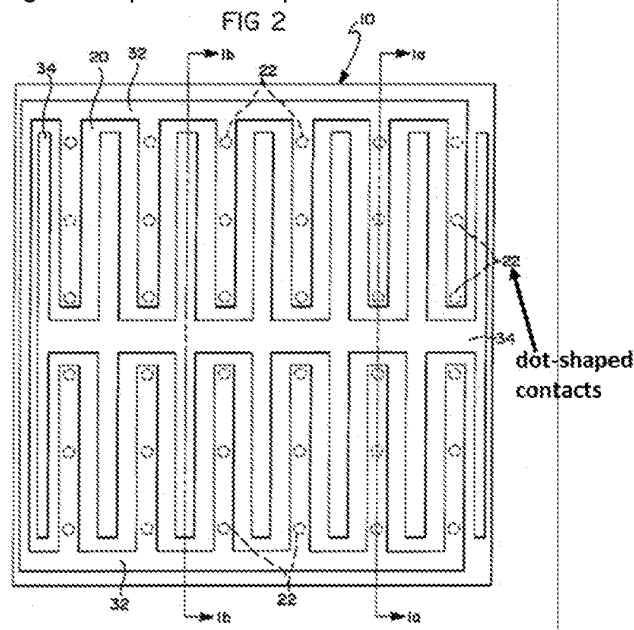


Highly doped region under contact having same corresponding shape

Modification of Meier with Wenham results in a plurality of N⁺⁺-type doped regions which have corresponding shapes to the contacts of Meier. Examiner notes that Meier was combined with Wenham to have these regions of high n-type doping under each of the contacts to reduce contact resistance similar to the regions shown in Fig. 5 of Wenham. As can be seen in the annotated figure the region of high doping (18 and 23) correspond in shape to the contacts (19 and 24).

Modified Meier does not explicitly disclose dot shaped contacts or dot shaped contact regions. Instead, Meier modified with Wenham discloses contacts with correspondingly shaped highly doped regions beneath the contact.

Xi discloses that point contacts can have a dot shape (See C3/L40-45 and Fig. 2 as produced below). Meier was modified with Xi so that the contacts will have a dot shape. Due to the previous modification of Meier with Wenham, the plurality of contacts will have a plurality of correspondingly shaped highly doped regions beneath the contacts. The plurality of dot shaped n-type doped regions will be present in modified Meier beneath the dot shaped metal contacts because as disclosed by Wenham the regions of high doping correspond in shape to the metal contacts.



Appellant argues that there is no support for the conclusion that a doped-region will necessarily have the same shape as its contact. Applicant argues that there is no reason why a point contact cannot be used to connect to planar regions.

Examiner notes that Wenham discloses a solar cell wherein the areas (see Fig. 5, portions 18 and 23) beneath contacts (see Fig. 5, below, contacts 19 and 24) are highly doped, and providing these highly doped areas under the contacts reduces contact resistance (C1/L25-41). Examiner notes that in addition to the highly doped regions (p++ and n++ regions directly under contact, 23 and 18) there also exists planar p+ and n+ regions (22 and 13) in the substrate of Wenham. Examiner notes that the addition of the highly doped regions under the contacts is disclosed by Wenham as reducing contact resistance (C1/L25-41) and these contact shaped regions are in addition to planar regions (p+ and n+ regions 22 and 13).

Wenham further discloses (see Figs. 1-3) that the areas of high doping beneath the contacts have shapes which correspond to the shape of the contacts because the high doped regions localized regions (15) are formed in a plating mask (see mask 12) and the localized regions (15) are subsequently plated with metal (19 see Fig. 3) to form contact (see area 18 of Fig. 3, which corresponds to where metal contact (19) is placed, C4/L20-24).

Regarding claims 22 and 23, Appellant further argues that the claims are patentable over the combination of Meier, Okayasu, Borden, Wenham, Jordan, and Xi at least for depending from claim 21.

With respect to Appellant's arguments for claims 22 and 23, as set forth above Examiner finds that the above combination of prior art teaches all of the claim elements as recited in claim 21.

Regarding claims 24, 25, and 27-29, Appellant argues that the claims are patentable over the combination of Meier, Okayasu, Borden, Wenham, Jordan, and Agnostinelli at least for depending from claim 21.

With respect to Appellant's arguments for claims 24, 25, and 27-29 as set forth above, Examiner finds that the above combination of prior art teaches all of the claim elements as recited in claim 21.

Regarding claim 26, Appellant argues that the claims is patentable over Meier, Okayasu, Borden, Wenham, Jordan, Xi, Agnostinelli, Russell, and Kray at least for depending from claim 21.

With respect to Appellant's arguments for claim 26 as set forth above, Examiner finds that the above combination of prior art teaches all of the claim elements as recited in claim 21.

Regarding claim 30, Appellant argues that the combination of Meier, Okayasu, Borden, Wenham, Jordan, and Xi does not teach or suggest the recited plurality of dot-shaped doped regions that are connected to a metal contact, and Tsunomura does not add to the combination of Meier, Okayasu, Borden, Wenham, Jordan, and Xi regarding the recited dot-shaped doped regions that are connected to the metal contact.

Examiner notes that the combination of Meier, Okayasu, Borden, Wenham, Jordan, and Xi does teach or suggest the recited plurality of dot-shaped doped regions

that are connected to a metal contact as set forth above (please see response to arguments with respect to claim 21).

Regarding claims 31-35, Appellant further argues that the claims are patentable over the combination of Meier, Okayasu, Borden, Wenham, Jordan, Xi, and Tsunomura at least for depending from claim 30.

With respect to Appellant's arguments for claims 31-35 as set forth above, Examiner finds that the above combination of prior art teaches all of the claim elements as recited in claim 30.

Regarding claim 36, Appellant argues that the claim is patentable over the combination of Meier, Okayasu, Borden, and Tsunomura at least for reciting: "a plurality of dot-shaped doped regions in the substrate under the antireflective layer, each of the plurality of dot shaped doped regions having a dot shape as seen from a plan view of the first solar cell" and "a first metal contact disposed on the front surface of the N-type silicon substrate perpendicular to the first bus bar, wherein the first metal contact is in electrical contact with the plurality of dot-shaped doped regions". Appellant argues as explained above, the combination of Meier, Okayasu, Borden, Wenham, Jordan, and Xi does not teach or suggest the recited plurality of dot-shaped doped regions that are connected to a metal contact. It is respectfully submitted that Tsunomura does not add to the combination of Meier, Okayasu, Borden, Wenham, Jordan, and Xi regarding the recited dot-shaped doped regions that are connected to the metal contact.

Examiner notes that the combination of Meier, Okayasu, Borden, Wenham, Jordan, and Xi does teach or suggest the recited plurality of dot-shaped doped regions

are connected to a metal contact as set forth above (please see response to arguments with respect to claim 21).

Regarding claims 37-40, Appellant further argues that the claims are patentable over the combination of Meier, Okayasu, Borden, Wenham, Jordan, Xi, and Tsunomura at least for depending from claim 36.

With respect to Appellant's arguments for claims 37-40 as set forth above, Examiner finds that the above combination of prior art teaches all of the claim elements as recited in claim 36.

For the above reasons, it is believed that the rejections should be sustained.

Respectfully submitted,

/DEVINA PILLAY/
Primary Examiner, Art Unit 1726

Conferees:
/JEFFREY T BARTON/
Supervisory Patent Examiner, Art Unit 1726

/Jennifer McNeil/
Primary Examiner, TC 1700

Requirement to pay appeal forwarding fee. In order to avoid dismissal of the instant appeal in any application or ex parte reexamination proceeding, 37 CFR 41.45 requires payment of an appeal forwarding fee within the time permitted by 37 CFR 41.45(a), unless appellant had timely paid the fee for filing a brief required by 37 CFR 41.20(b) in effect on March 18, 2013.

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

First Named Inventor:

Peter John COUSINS

Application No.: 16/460,035

Examiner: PILLAY, DEVINA

Filing Date: July 2, 2019

Art Unit: 1726

Title: FRONT CONTACT SOLAR CELL WITH FORMED EMITTER

REPLY BRIEF FILED UNDER 37 C.F.R. § 41.41

This Reply Brief is responsive to the Examiner's Answer mailed January 11, 2021 and follows the Appeal Brief submitted by the appellant on December 1, 2020.

REMARKS

This Reply Brief responds to the contentions in the Examiner's Answer. Detailed explanations why the pending claims are patentable over the references of record are provided in the Appeal Brief, and not repeated here in the interest of clarity and brevity.

A. CLAIMS 21-40

Claims 21-23 are rejected under pre-AIA 35 U.S.C. §103(a) as being unpatentable over Meier (US 6,262,359) in view of Okayasu (JP07-106611), Borden (WO 2009/094578), Wenham (US 6,429,037), Jordan (US 2005/0268963), and Xi (US 4,865,999). The rejection is respectfully traversed.

Claim 21 is patentable over the combination of Meier, Okayasu, Borden, Wenham, Jordan, and Xi least for reciting: "a plurality of dot-shaped N-type doped regions in the N-type silicon substrate under the antireflective layer, each of the plurality of dot-shaped doped regions having a dot shape as seen from a plan view of the solar cell" and "a first metal contact disposed on the front surface of the N-type silicon substrate, wherein the first metal contact is in electrical contact with the plurality of dot-shaped N-type doped regions."

As fully explained in the Appeal Brief, the combination of Meier, Okayasu, Borden, Wenham, Jordan, and Xi does not teach or suggest a metal contact on the front side that is in electrical contact with a plurality of dot-shaped N-type doped regions under the antireflective layer.

As noted in the Examiner's Answer, "Modified Meier does not explicitly disclose dot shaped contacts or dot shaped contact regions" (Examiner's Answer, page 19). Furthermore, the Examiner's Answer does not contend that Xi discloses dot-shaped doped regions. The gist of the Examiner's Answer is that "Meier modified with Wenham discloses contacts with correspondingly shaped highly doped regions beneath the contact" and "Meier was modified with Xi that the contacts will have a dot shape" (Examiner's Answer, page 19). Appellant respectfully submits that there is no support for this conclusion.

Wenham does not teach or suggest that a doped region follows the shape of its contact. In fact, Wenham has no discussion regarding the shape of a doped region relative to its contact. As shown in Wenham FIG. 5, reproduced in the Examiner's Answer with annotations, Wenham discloses a planar N-type doped region 13, which serves as a lightly-diffused emitter (Wenham, col. 4, lines 29-35), across the surface of the P-type substrate. The planar shape of the N-type doped region 13 is due to the diffusion of N-type dopants from the dielectric layer 12, which is across the surface of the substrate (Wenham, col. 4, lines 20-40; FIGS. 2-5). The laser 14 heats the same dielectric layer 12, which causes N-type dopants from the dielectric layer 12 to diffuse more heavily on regions directly hit by the laser 14. However, Wenham does not teach or suggest that the N-type doped region 13 has the same shape as the contact 19 (see Wenham FIG. 5).

As noted in the Appeal Brief, the point contacts 22 of Xi, which the Examiner's Answer relies on to show dot-shaped doped regions, are *contacts* as opposed to doped regions. As shown in Xi, FIG. 3C, the openings in the amorphous layer 16 are formed by first forming the contacts 22 and then depositing the amorphous layer 16 to surround the contacts 22 (Xi, col. 4, lines 27-46). So, in Xi, it is clear that the contacts 22 are contacts – there are no doped region in the openings where the contacts 22 are formed. Furthermore, the TCO layer 14 under the contacts 22 are not dot-shaped doped regions.

It is thus respectfully submitted that there is no support for the conclusion that a doped-region will necessarily have the same shape as its contact. There is no reason why a point contact cannot be used to connect to planar doped regions. That is, modifying Meier to have point contacts as taught by Xi will result in the modified Meier having point contacts connected to the N-type layer 216 of Meier. The modified Meier will still have the same N-type layer 216, which is not an N-type dot-shaped doped region as recited.

CONCLUSION

For at least the above reasons, allowance of the pending claims is respectfully requested.

Attorney Docket No. 10031.004212
Reply Brief

Respectfully submitted,

Dated: March 10, 2021

/Patrick D. Benedicto/
Patrick D. Benedicto, Reg. No. 40,909
Okamoto & Benedicto LLP
P.O. Box 641330
San Jose, CA 95164
Tel.: (408)436-2112

Electronic Patent Application Fee Transmittal				
Application Number:		16460035		
Filing Date:		02-Jul-2019		
Title of Invention:		FRONT CONTACT SOLAR CELL WITH FORMED EMITTER		
First Named Inventor/Applicant Name:		Peter John COUSINS		
Filer:		Patrick D. Benedicto		
Attorney Docket Number:		10031.004212		
Filed as Large Entity				
Filing Fees for Utility under 35 USC 111(a)				
Description	Fee Code	Quantity	Amount	Sub-Total in USD(\$)
Basic Filing:				
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				
APPEAL FORWARDING FEE	1413	1	2360	2360
Post-Allowance-and-Post-Issuance:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD(\$)
Extension-of-Time:				
Miscellaneous:				
Total in USD (\$)				2360

Electronic Acknowledgement Receipt	
EFS ID:	42147961
Application Number:	16460035
International Application Number:	
Confirmation Number:	5633
Title of Invention:	FRONT CONTACT SOLAR CELL WITH FORMED EMITTER
First Named Inventor/Applicant Name:	Peter John COUSINS
Customer Number:	74254
Filer:	Patrick D. Benedicto
Filer Authorized By:	
Attorney Docket Number:	10031.004212
Receipt Date:	10-MAR-2021
Filing Date:	02-JUL-2019
Time Stamp:	19:15:17
Application Type:	Utility under 35 USC 111(a)

Payment information:

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Payment Type	CARD
Payment was successfully received in RAM	\$2360
RAM confirmation Number	E202130J16231262
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Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Reply Brief Filed	10031004212_ReplyBrief.pdf	117060	no	4
			ef9ddfd7ad32f3bb461351ba2dbe4251c21b1181		
Warnings:					
Information:					
2	Fee Worksheet (SB06)	fee-info.pdf	30424	no	2
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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
16/460,035	07/02/2019	Peter John COUSINS	10031.004212	5633
74254 7590 03/12/2021 Okamoto & Benedicto LLP (SunPower) P.O. Box 641330 San Jose, CA 95164-1330			EXAMINER PILLAY, DEVINA	
			ART UNIT 1726	PAPER NUMBER
			MAIL DATE 03/12/2021	DELIVERY MODE PAPER

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

Ex parte PETER JOHN COUSINS

Appeal 2021-002647
Application 16/460,035
Technology Center 1700

APPEAL DOCKETING NOTICE

The Patent Trial and Appeal Board received the appeal in the above-identified application from the Technology Center on March 12, 2021, and has assigned it the appeal number indicated above.

The recipient of this notice is reminded of its ongoing duty, within 20 days of any change during the proceeding, to update its mandatory notices to identify the real party-in-interest and each judicial or administrative proceeding that could affect, or be affected by, the Board proceeding. 37 C.F.R. § 41.8. For example, another docketed appeal in a related application may have the potential to affect, or be affected by, the Board proceeding.

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Application Number	16/460,035
Filing Date	07-02-2019
First Named Inventor	Peter John Cousins
Title	FRONT CONTACT SOLAR CELL WITH FORMED EMITTER
Art Unit	1726
Examiner Name	Devina Pillay
Attorney Docket Number	SKYW00056 US

SIGNATURE of Applicant or Patent Practitioner			
Signature	/Jackson Ho/	Date (Optional)	
Name	Jackson Ho	Registration Number	72,360
Title (if Applicant is a juristic entity)	Attorney for Applicant		
Applicant Name (if Applicant is a juristic entity)	SunPower Corporation		
NOTE: This form must be signed in accordance with 37 CFR 1.33. See 37 CFR 1.4(d) for signature requirements and certifications. If more than one applicant, use multiple forms.			
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144187

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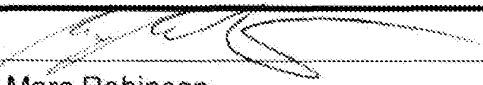
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	Country			
	Telephone	Email		

Assignee Name and Address: SunPower Corporation
51 Rio Robles
San Jose, CA 95134

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SIGNATURE of Assignee of Record

The individual whose signature and title is supplied below is authorized to act on behalf of the assignee

Signature		Date	27-Feb-2017
Name	Marc Robinson	Telephone	512.735.5911
Title	Senior IP Counsel		

This collection of information is required by 37 CFR 1.31, 1.32 and 1.33. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.31 and 1.14. This collection is estimated to take 3 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.

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Application Number	16/460,035
Filing Date	07-02-2019
First Named Inventor	Peter John Cousins
Art Unit	1726
Examiner Name	Devina Pillay
Attorney Docket Number	SKYW00056 US

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Applicant

☒Attorney or agent of record. Registration Number 72,360.☐

Registered practitioner named in the application transmittal papers who acts in a representative capacity under 37 CFR 1.34. See 37 CFR 1.33(a)(1). Registration Number _____.

Signature /Jackson Ho/

Typed or Printed
Name Jackson Ho

Date 04-13-2022

Telephone 408-331-1671

NOTE: This form must be signed in accordance with 37 CFR 1.33. See 37 CFR 1.4(d) for signature requirements and certifications.
Submit multiple forms if more than one signature is required, see below*.

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*Total of _____ forms are submitted.

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2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.
3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.
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5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.
6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).
7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (*i.e.*, GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.
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9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

Electronic Acknowledgement Receipt	
EFS ID:	45455108
Application Number:	16460035
International Application Number:	
Confirmation Number:	5633
Title of Invention:	FRONT CONTACT SOLAR CELL WITH FORMED EMITTER
First Named Inventor/Applicant Name:	Peter John COUSINS
Customer Number:	74254
Filer:	Jackson Ho/Julie Fosnaugh
Filer Authorized By:	Jackson Ho
Attorney Docket Number:	10031.004212
Receipt Date:	13-APR-2022
Filing Date:	02-JUL-2019
Time Stamp:	17:59:17
Application Type:	Utility under 35 USC 111(a)

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File Listing:					
Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Power of Attorney	SKYW00056US_16460035_POA_04122022_EF.pdf	1105210	no	2
			8888d4c98c1101b7f8699168d6f5ae6557ca bd3f		
Warnings:					

Information:					
2	Change of Address	S00123US3_SKYW00056US_ChangeCorresAddress_EF.pdf	226899	no	2
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APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
16/460,035	07/02/2019	Peter John COUSINS	10031.004212

CONFIRMATION NO. 5633

POWER OF ATTORNEY NOTICE



OC000000133190375

Date Mailed: 04/18/2022

74254
Law Office of Patrick D. Benedicto
P.O. Box 641330
San Jose, CA 95164-1330

NOTICE REGARDING CHANGE OF POWER OF ATTORNEY

This is in response to the Power of Attorney filed 04/13/2022.

- The Power of Attorney to you in this application has been revoked by the applicant. Future correspondence will be mailed to the new address of record(37 CFR 1.33).

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APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
16/460,035	07/02/2019	Peter John COUSINS	SKYW00056 US

CONFIRMATION NO. 5633

POA ACCEPTANCE LETTER



144187
Schmidt Patent Law, Inc.
2635 N. First Street
Suite 150
San Jose, CA 95134-2000

Date Mailed: 04/18/2022

NOTICE OF ACCEPTANCE OF POWER OF ATTORNEY

This is in response to the Power of Attorney filed 04/13/2022.

The Power of Attorney in this application is accepted. Correspondence in this application will be mailed to the above address as provided by 37 CFR 1.33.

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/zmoguss/



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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
16/460,035	07/02/2019	Peter John COUSINS	SKYW00056 US	5633
144187	7590	05/24/2022		
Schmidt Patent Law, Inc. 2635 N. First Street Suite 150 San Jose, CA 95134-2000			EXAMINER PILLAY, DEVINA	
			ART UNIT 1726	PAPER NUMBER
			NOTIFICATION DATE 05/24/2022	DELIVERY MODE ELECTRONIC

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UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

Ex parte PETER JOHN COUSINS

Appeal 2021-002647
Application 16/460,035
Technology Center 1700

Before ERIC B. GRIMES, GEORGE C. BEST, and DEBRAL. DENNETT,
Administrative Patent Judges.

BEST, *Administrative Patent Judge.*

DECISION ON APPEAL

Pursuant to 35 U.S.C. § 134(a), Appellant¹ appeals from the Examiner’s decision to reject claims 21–40 of Application 16/460,035. Final Act. (October 21, 2020). We have jurisdiction under 35 U.S.C. § 6.

For the reasons set forth below, we *affirm*.

¹ “Appellant” refers to “applicant” as defined in 37 C.F.R. § 1.42. Appellant identifies SunPower Corp. as the real party in interest. Appeal Br. 1.

I. BACKGROUND

The '035 Application describes improvements to solar cell structures and fabrication processes. Spec. 1. In particular, the Specification describes a front contact bipolar solar cell. *Id.* Such a solar cell includes backside junctions formed by N-type and P-type diffusion regions. *Id.* at 1–2. The solar cell further comprises metal contacts coupled to the diffusion regions. *Id.* These metal contacts allow an external electrical circuit to be coupled to and powered by the solar cell. *Id.* at 2. In a front contact solar cell, at least one of the metal contacts that is electrically connected to diffusion regions is located on the front side of the solar cell. *Id.*

Claim 21 is representative of the '035 Application's claims and is reproduced below from the Appeal Brief's Claims Appendix.

21. A solar cell, the solar cell comprising:

- a N-type silicon substrate having a front surface and a back surface, wherein the front surface comprises a textured surface;

- an antireflective layer over the front surface of the N-type silicon substrate;

- a plurality of dot-shaped N-type doped regions in the N-type silicon substrate under the antireflective layer, each of the plurality of dot-shaped doped regions having a dot shape as seen from a plan view of the solar cell;*

- an oxide region disposed on the back surface of the N-type silicon substrate;

- a polysilicon emitter disposed on the oxide region;

- a first metal contact disposed on the front surface of the N-type silicon substrate, wherein the first metal contact is in electrical contact with the plurality of dot-shaped N-type doped regions; and

a second metal contact disposed on the polysilicon emitter.

Appeal Br. 9 (emphasis added).

II. REJECTIONS

On appeal, the Examiner maintains the following rejections:

1. Claims 21–23 are rejected under 35 U.S.C. § 103(a) as unpatentable over the combination of Meier,² Okayasu,³ Borden,⁴ Wenham,⁵ Jordan,⁶ and Xi.⁷ Final Act. 2.

2. Claims 24, 25, and 27–29 are rejected under 35 U.S.C. § 103(a) as unpatentable over the combination of Meier, Okayasu, Borden, Wenham, Jordan, Xi, and Agnostinelli.⁸ Final Act. 5–6.

² US 6,262,359 B1, issued July 17, 2001.

³ JP 07106611 A, published April 21, 1995. We rely upon a translation made of record on July 6, 2020.

⁴ WO 2009/094578 A2, published July 30, 2009.

⁵ US 6,429,037 B1, issued August 6, 2002.

⁶ US 2005/0268963 A1, published December 8, 2005.

⁷ US 4,865,999, issued September 12, 1989.

⁸ US 2009/0301557 A1, published December 10, 2009.

(Cont'd)

3. Claim 26 is rejected under 35 U.S.C. § 103(a) as unpatentable over the combination of Meier, Okayasu, Borden, Wenham, Jordan, Xi, Agnostinelli, Russell,⁹ and Kray.¹⁰ Final Act. 7.

4. Claims 30–40 are rejected under 35 U.S.C. § 103(a) as unpatentable over the combination of Meier, Okayasu, Borden, Wenham, Xi, Jordan, and Tsunomura.¹¹ Final Act. 8.

III. DISCUSSION

A. Rejection of claims 21–23 over the combination of Meier, Okayasu, Borden, Wenham, Jordan, and Xi

Claim 21 is an independent claim. Claims 22 and 23 depend from claim 21. In arguing for reversal of this rejection, Appellant only presents arguments with respect to the patentability of claim 21. *See* Appeal Br. 3–6. Claims 22 and 23 are said to be allowable based on their dependence from claim 21. *See id.* at 6. We, therefore, select claim 21 as representative of the claims subject to this ground of rejection and limit our discussion accordingly. 37 C.F.R. § 41.37(c)(1)(iv) (2019).

Appellant argues that the rejection of claim 21 should be reversed because the combination of references relied upon by the Examiner does not describe or suggest the plurality of dot-shaped N-type doped regions recited in claim 21. Appeal Br. 4–6. According to Appellant, the Examiner relied upon Xi as describing the recited dot-shaped N-type doped regions. *Id.* at 5.

⁹ US 2008/0216893 A1, published September 11, 2008.

¹⁰ Daniel Kray et al., *Study on the edge isolation of industrial silicon solar cells with waterjet-guided laser*, 91 Solar Energy Materials & Solar Cells 1638–44 (2007).

¹¹ US 2008/0121266 A1, published May 29, 2008.

Appellant contends that Xi describes dot-shaped contacts rather than dot-shaped N-type doped regions. *Id.* at 5–6.

We are not persuaded by this argument, which does not correctly present the Examiner’s basis for the rejection.

In the Final Action, the Examiner found that Meier describes point-style contacts “but does not disclose that under the point contacts there is a highly doped region which [is] dot shaped.” Final Act. 3. The Examiner further found that Wenham describes a solar cell having point contacts and areas of high doping underneath the point contacts. *Id.* (citing Wenham 1:25–41; Fig. 5) The Examiner also found that Xi describes dot-shaped electrical contacts for use in solar cells. *Id.* (citing Xi 3:40–45). In the Final Action, the Examiner states, in a conclusory manner, that “the cross-sectional shape of the point contact of modified Meier will have the corresponding the [sic] plurality of dot-shaped doped regions having a dot shape as seen from a plan view of the solar cell.” *Id.*

In the Examiner’s Answer, however, the Examiner responds to Appellant’s arguments by providing a more reasoned explanation for the finding regarding the dot shape of the doped regions underlying the dot-shaped point contacts. *See* Answer 17–20. According to the Examiner, if the point contacts in Meier as modified by Wenham are dot-shaped as described in Xi, the highly doped regions underneath the dot-shaped point contacts will also be dot-shaped because Wenham describes creating the highly doped regions through the same plating mask used to control the shape of the metal plating that creates the contact. *Id.* at 20.

Appellant does not address the Examiner’s argument in its Reply Brief.

We agree with the Examiner that the highly doped regions under the dot-shaped electrodes in the Examiner's proposed combination of Meier, Wenham, and Xi would have the same shape as the electrodes. Wenham describes using a laser to create the pattern in the metallization mask and dope the region under the mask in a single process step. Wenham 4:21–40.

In view of the foregoing, we affirm the rejection of claim 21. Thus, we also affirm the rejection of claims 22 and 23.

B. Rejection of claims 24, 25, and 27–29 over the combination of Meier, Okayasu, Borden, Wenham, Jordan, Xi, and Agnostinelli

Appellant argues that the rejection of claims 24, 25, and 27–29 should be reversed by virtue of the dependence of these claims from claim 21. Appeal Br. 6. Because we have affirmed the rejection of claim 21, we also affirm the rejection of claims 24, 25, and 27–29.

C. Rejection of claim 26 over the combination of Meier, Okayasu, Borden, Wenham, Jordan, Xi, Agnostinelli, Russell, and Kray

Appellant argues that the rejection of claim 26 should be reversed by virtue of its dependence from claim 21. Appeal Br. 7. Because we have affirmed the rejection of claim 21, we also affirm the rejection of claim 26.

D. Rejection of claims 30–40 over the combination of Meier, Okayasu, Borden, Wenham, Xi, Jordan, and Tsunamora

Appellant divides the claims subject to this ground of rejection into two groups: Independent claim 30 and claims 31–35, which depend from claim 30, and independent claim 36 and claims 37–40 which depend from claim 36. Appeal Br. 7–8. We address each group of claims separately.

1. Claims 30–35

Appellant only presents arguments for reversal of the rejection of independent claim 30. We, therefore, choose claim 30 as representative of this group of claims and limit our discussion accordingly. 37 C.F.R. § 41.37(c)(1)(iv).

Appellant argues that the rejection of claim 30 should be reversed on the basis of the arguments presented for reversal of the rejection of claim 21 and because Tsunomura does not cure the defects in the rejection of claim 21. Appeal Br. 7.

For the reasons set forth above, we have affirmed the rejection of claim 21. Thus, we also affirm the rejection of independent claim 30 and its dependent claims 31–35.

2. Claims 36–40

Appellant only presents arguments for reversal of the rejection of independent claim 36. We, therefore, choose claim 36 as representative of this group of claims and limit our discussion accordingly. 37 C.F.R. § 41.37(c)(1)(iv).

Appellant argues that the rejection of claim 36 should be reversed on the basis of the arguments presented for reversal the rejection of claim 21. Appellant further contends that Tsunomura does not cure the defects in the rejection of claim 21. Appeal Br. 7.

For the reasons set forth above, we have affirmed the rejection of claim 21. Thus, we also affirm the rejection of independent claim 36 and its dependent claims 37–40.

IV. CONCLUSION

In summary:

Claim(s) Rejected	35 U.S.C. §	Reference(s)/Basis	Affirmed	Reversed
21–23	103	Meier, Okayasu, Borden, Wenham, Jordan, Xi	21–23	
24, 25, 27–29	103	Meier, Okayasu, Borden, Wenham, Jordan, Xi, Agnostinelli	24, 25, 27–29	
26	103	Meier, Okayasu, Borden, Wenham, Jordan, Xi, Agnostinelli, Russell, Kray	26	
30–40	103	Meier, Okayasu, Borden, Wenham, Xi, Jordan, Tsunamora	30–40	
Overall Outcome			21–40	

V. TIME PERIOD FOR RESPONSE

No time period for taking any subsequent action in connection with this appeal may be extended under 37 C.F.R. § 1.136(a).

AFFIRMED



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Schmidt Patent Law, Inc. 2635 N. First Street Suite 150 San Jose, CA 95134-2000			EXAMINER PILLAY, DEVINA	
			ART UNIT 1726	PAPER NUMBER
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<i>Notice of Abandonment</i>	Application No.	Applicant(s)
	16/460,035	COUSINS, Peter John
	Examiner	Art Unit
	DEVINA PILLAY	1726

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address--

This application is abandoned in view of:

1. ☐ Applicant's failure to timely file a proper reply to the Office letter mailed on _____.
 - (a) ☐ A reply was received on _____ (with a Certificate of Mailing or Transmission dated _____), which is after the expiration of the period for reply (including a total extension of time of _____ month(s)) which expired on _____.
 - (b) ☐ A proposed reply was received on _____, but it does not constitute a proper reply under 37 CFR 1.113 to the final rejection. (A proper reply under 37 CFR 1.113 to a final rejection consists only of: (1) a timely filed amendment which places the application in condition for allowance; (2) a timely filed Notice of Appeal (with appeal fee); or (3) if this is utility or plant application, a timely filed Request for Continued Examination (RCE) in compliance with 37 CFR 1.114. Note that RCEs are not permitted in design applications.)
 - (c) ☐ A reply was received on _____ but it does not constitute a proper reply, or a *bona fide* attempt at a proper reply, to the non-final rejection. See 37 CFR 1.85(a) and 1.111. (See explanation in box 8 below).
 - (d) ☐ No reply has been received.

2. ☐ Applicant's failure to timely pay the required issue fee and publication fee, if applicable, within the statutory period of three months from the mailing date of the Notice of Allowance (PTOL-85).
 - (a) ☐ The issue fee and publication fee, if applicable, was received on _____ (with a Certificate of Mailing or Transmission dated _____), which is after the expiration of the statutory period for payment of the issue fee (and publication fee) set in the Notice of Allowance (PTOL-85).
 - (b) ☐ The submitted fee of \$ _____ is insufficient. A balance of \$ _____ is due.
The issue fee required by 37CFR 1.18 is \$ _____. The publication fee, if required by 37 CFR 1.18(d), is \$ _____.
 - (c) ☐ The issue fee and publication fee, if applicable, has not been received.

3. ☐ Applicant's failure to timely file corrected drawings as required by, and within the three-month period set in, the Notice of Allowability (PTO-37).
 - (a) ☐ Proposed corrected drawings were received on _____ (with a Certificate of Mailing or Transmission dated _____), which is after the expiration of the period for reply.
 - (b) ☐ No corrected drawings have been received.

4. ☐ The letter of express abandonment which is signed by the attorney or agent of record or other party authorized under 37 CFR 1.33 (b). See 37 CFR 1.138(b).

5. ☐ The letter of express abandonment which is signed by an attorney or agent (acting in a representative capacity under 37 CFR 1.34) upon the filing of a continuing application.

6. ☒ The decision by the Patent Trial and Appeal Board rendered on 24 May 2022 and because the period for seeking court review of the decision has expired and there are no allowed claims.

7. ☐ The dismissal of the appeal in an application having no allowed claims. (When an appeal is dismissed in an application having no allowed claims the application stands abandoned. See MPEP 1215.04 subsections I-V for an explanation of the reasons why an appeal is dismissed.)

8. ☐ The reason(s) below:

/DEVINA PILLAY/ Primary Examiner, Art Unit 1726	
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Petitions to revive under 37 CFR 1.137, or requests to withdraw the holding of abandonment under 37 CFR 1.181, should be promptly filed to minimize any negative effects on patent term.