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Issuing Date:

Application No. or Publication No.: 202011335191.9

Issue No.:

Applicant or Patentee: Co. Ltd., Committer Atts Sunlight Energy Technology Co., Ltd.

Title of Invention: SOLAR CELL AND METHOD OF MAKING THE SAME

First Office Action

1. ☒ Upon the request of substantive examination of the applicant, in accordance with Article 35.1 of the Patent Law, the State Intellectual Property Office performs the substantive examination for the aforesaid application for a patent for invention.

☐ In accordance with Article 35.2 of the Patent Law, the State Intellectual Property Office proceeds to examine the aforesaid application for a patent for invention as to its substance on its own initiative.

2. ☐ The applicant requests on the basis of:

☐ The applicant has submitted the copy of previous application documents for the first filed, which has been verified by the original receiving organization.

☐ The applicant has not submitted the copy of previous application documents for the first filed, which has been verified by the original receiving organization. In accordance with Article 30 of the Patent Law, the claim to the right of priority shall be deemed not to have been made.

3. ☐ Upon examination, the amendment submitted by the applicant on __, shall not be accepted for not in conformity with Rule 51.1 of the Implementing Regulations of the Patent Law.

4. Application files for examination:

☒ Original application documents. ☐ Documents submitted on the date of submission of divisional application. ☐ Following application documents:

5. ☐ The decision of this Office Action has been made without search.

☒ The decision of this Office Action has been made based on search.

☒ The following reference documents are cited in this Office Action (the serial number(s) of which will be used in follow-on examination):

No.	Document number or Document title	publication date (or application date of the conflicting
1	CN210443566U	2020-05-01



2	CN109564951A	2019-04-02
3	CN210897294U	2020-06-30
4	CN110707182A	2020-01-17

6. Conclusive opinions of the examination:

About the description:

☐ The application falls into the scope of subject matter which is nonpatentable according to Article 5 of the Patent Law.

☐ The description fails to comply with the provisions of article 26.3 of the Patent Law.

☐ The description fails to comply with the provisions of Article 33 of the Patent Law.

☐ The drafting of the description fails to comply with Rule 17 of the Implementing Regulations of the Patent Law.

☐ _____

About the claims:

☐ The claim(s) _____ fail(s) to comply with the provisions of Article 2.2 of the Patent Law.

☐ The claim(s) _____ fail(s) to comply with the provisions of Article 9.1 of the Patent Law.

☐ The claim(s) _____ fail(s) to comply with the novelty requested by Article 22.2 of the Patent Law. ☐

☒ The claim(s) 1-23 fail(s) to comply with the inventive steps requested by Article 22.3 of the Patent Law.

☐ The claim(s) _____ fail(s) to comply with the applicability requested by Article 22.4 of the Patent Law.

☐ The claim(s) _____ fail(s) into the scope of subject matter which is nonpatentable according to Article 25 of the Patent Law.

☐ The claim(s) _____ fail(s) to comply with the provisions of Article 26.4 of the Patent Law.

☐ The claim(s) _____ fail(s) to comply with the provisions of Article 31.1 of the Patent Law.

☐ The claim(s) _____ fail(s) to comply with the provisions of Article 33 of the Patent Law.

☐ The claim(s) _____ fail(s) to comply with the provisions of Rule 19 of the Implementing Regulations of the Patent Law.

☐ The claim(s) _____ fail(s) to comply with the provisions of Rule 20 of the Implementing Regulations of the Patent Law.

☐ The claim(s) _____ fail(s) to comply with the provisions of Rule 21 of the Implementing Regulations of the Patent Law.

☐ The claim(s) _____ fail(s) to comply with the provisions of Rule 22 of the Implementing Regulations of the Patent Law.

☐ _____

☐ The application fails to comply with the provisions of Article 26.5 of the Patent Law or Rule 26 of its Implementing Regulations.



☐The application fails to comply with the provisions of Article 20.1 of the Patent Law.

☐The divisional application fails to comply with the provisions of Rule 43.1 of the Implementing Regulations of the Patent Law.

The detailed analyses of the above conclusive opinions refer to the text of this Office Action.

7. On the basis of the conclusive opinions, the examiner suggests:

☐The applicant should amend the application documents according to the text of this Office Action.

☐The applicant should state the reasons why the patent application should be granted in the observation, and amend the part which fails to comply with the provisions according to this Office Action, otherwise the patent application should not be granted.

☒The substantive content that might be granted can not be found in the application, if the applicant does not state the reasons or the stated reasons are not sufficient, the application shall be rejected.

☐_____

8. The applicant should pay attention to the followings statements:

(1) In accordance with Article 37 of the Patent Law, the applicant should submit the written opinion within four months from the date of receipt of this Office Action. If, without any justified reason, the time limit for reply is not met, the application shall be deemed to have been withdrawn.

(2) The amendment of the application document by the applicant should be in conformity with Article 33 of the Patent Law, and it should not exceed the scope specified in the initial description and claims. Meanwhile, the amendment of the application document by applicant should be in conformity with Rule 51.3 of the Implementing Regulations of the Patent Law, and in accordance with this Office Action.

(3) The written opinion and/or amendment document of the applicant should be sent by mail or submitted directly to the Receiving Division of the Patent Office of the State Intellectual Property Office, otherwise it will be considered to have no legal effect.

(4) Without appointment, the applicant and/or the agent should not come to the Patent Office of the State Intellectual Property Office to have an interview with the examiner.

9. The text of this Office Action has 4 pages, and the attachments are as follows:

☐The total number of copies of the reference documents cited is copies and pages.

☐_____



The First Office Action

Application

Number: 2020113351919

Upon review, the following review comments are now presented.

1. Claim 1 claims a solar cell, comparative document 1 (CN210443566U) discloses a solar cell, and specifically discloses (see specification paragraphs 0020-0036, Figures 2-3): comprising a silicon wafer 10 (i.e. A silicon substrate), front and back electrodes 20, 30 respectively arranged on opposite sides of said silicon wafer 10 (i.e. Front and back electrodes respectively arranged on two sides of the silicon substrate), the front side of the silicon wafer 10 is formed with a diffusion layer 11, the silicon wafer has a first region and a second region, the front side of the first region being stacked with a tunneling layer 40 and a doped silicon carbide layer 50, an antireflection layer 60 disposed on the diffusion layer 11 of the doped silicon carbide layer 50 and the second region (i.e. The front side of the silicon substrate being stacked with a tunneling layer and a doped polysilicon layer, and the front side of the second portion being formed with a doped layer). The front electrode 20 penetrates the antireflection layer 60 and forms an ohmic contact with the doped silicon carbide layer 50 (i.e. The front electrode is in contact with the doped polysilicon layer), the first region being typically provided larger than the electrode region corresponding to the front electrode 20, so that the front electrode 20 does not exceed the doped silicon carbide layer 50.

The solution of this claim differs from Comparative Document 1 in that the back side of the silicon substrate is provided with an intrinsic amorphous silicon layer, a doped amorphous layer and a transparent conductive layer in that order, and the back side electrode is provided on a surface of the transparent conductive layer facing away from the side of the silicon substrate. Based on the above distinctions, the technical problem to be practically solved by the technical solution of this claim is how to arrange the back electrode.

Comparative document 2 (CN109564951 A) discloses a solar cell and a method for manufacturing a solar cell, and specifically discloses (see Detailed Description, Figures 1-4): As shown in Figure 1, the back side of the silicon substrate 12 is provided with an intrinsic amorphous silicon passivation layer 15, a p-type amorphous silicon layer 16 and a transparent conductive layer 22 in this order (i.e. The back side of the silicon substrate is provided with an intrinsic amorphous silicon layer, a doped amorphous layer and a transparent conductive layer in this order), the back electrode 23 is disposed on the surface of the transparent conductive layer on the side facing away from the silicon substrate (i.e. The back electrode is disposed on the surface of the transparent conductive layer on the side facing away from the silicon substrate).

And its role in Comparative Document 2 is the same as its role in Claim 1, all for providing the back electrode. That is, Comparative Document 2 gives insight to use the above-described distinguishing features for Comparative Document 1 to solve the technical problem thereof. Therefore, it will be obvious to those skilled in the art that the technical solution of this claim is derived from Comparative Document 1 in conjunction with Comparative Document 2, so that the technical solution claimed in this claim has no outstanding substantive features and significant advancements, without the inventive step specified by Article 22, Article 3 of the Patent law.

2. Claim 2 with reference to Claim 1, for additional technical features defining parts thereof, Comparative Document 1 discloses that the first regions are generally provided larger than the corresponding electrode regions of the front electrodes 20, so that the front electrodes 20 do not exceed the doped silicon carbide layer 50. Thus, to the extent that a claim is relied upon without inventive step, the claim does not have the inventive step as set forth in



clause 22, clause 3 of the patent law.

3. Claims 3-7, 10, 12-13 refer to claim 1, and for additional technical features in defining parts thereof, Comparative Document 1 discloses a doping concentration of a doped silicon carbide layer 50 between $1\text{E}19$ and $1\text{E}21\text{ cm}^{-3}$ and the thickness of said doped silicon carbide layer 50 is set to 10-500 nm, Comparative Document 2 further discloses that the tunneling layer 13 is a silicon oxide film; the thickness of the intrinsic amorphous silicon passivation layer 15 is 5-10 nm; the p-type amorphous silicon layer 16 has a thickness of 5 to 25 nm, and a concentration of the p-type dopant is, for example, $1 \times 10^{20}\text{ atoms/cm}^3$ or higher; the transparent conductive layer 22 has a thickness of 30 to 500 nm; the silicon substrate is an N-type silicon wafer, the doped polysilicon layer 14 is n-type doped, the doped p-type amorphous silicon layer 16, the n-type dopant may be phosphorus, and the p-type dopant may be boron. And Comparative Document 3 (CN210897294U) discloses a solar cell, and specifically discloses (see specific examples of the description, Figures 1-4) that a doped polysilicon layer comprises a first portion 31 and a second portion 32, a front electrode being correspondingly arranged on the first portion 31, the thickness of the first portion 31 being greater than the thickness of the second portion 30; the thickness of the first portion 31 may be set to 80-300 nm; the thickness of the second portion 32 is preferably between 10 and 80 nm; the doping concentration of the first portion 31 is greater than the doping concentration of the second portion 32, the doping concentration of the first portion 31 being between $1\text{E}20$ and $8\text{E}20\text{ cm}^{-3}$; the doping concentration of the second portion 32 is $2\text{E}19$ - $8\text{E}19\text{ cm}^{-3}$; the tunneling layer 20 is provided as a silicon oxide film or a silicon oxynitride film or a composite film formed by stacking both a silicon oxide film and a silicon oxynitride film and having a thickness of 0.5 to 3 nm; the antireflection layer 40 can be provided in a laminated or graded film layer structure, the antireflection layer 40 has a first antireflection film layer, a second antireflection film layer disposed in layers on a surface of the first antireflection film layer facing away from said semiconductor substrate 10, and the thickness of the first antireflection film layer is lower than the thickness of the second antireflection film layer, the refractive index of the first antireflection film layer is higher than the refractive index of the second antireflection film layer, the antireflection layer 40 consists of several silicon nitride film layers with different refractive indices and thicknesses, or silicon oxide and silicon oxynitride film layers with relatively small refractive indices may also be provided in the antireflection layer 40. On this basis, it is conventional to arrange the first antireflection layer as a hydrogen-rich silicon nitride film having a thickness of 3-30 nm, a refractive index of 2.1-2.4, and the second antireflection layer as a silicon nitride film or a silicon oxynitride film or a silicon oxide film or a composite film consisting of at least two thereof. The transparent conductive layer thickness was set to 70-120 nm, which is also a conventional setting. Accordingly, to the extent that a claim is relied upon is not inventive, such claim is not inventive as set forth in clause 22, clause 3 of the patent law.

4. Claims 8, 11 depending on claim 1, claim 9 with reference to claim 8, additional technical features defining parts thereof constitute a further distinction from comparative document 1, comparative document 4 (CN110707182A) discloses a heterojunction cell preparation method, and discloses (cf. Claims 1-13, specific examples of the description): the heterojunction passivation layer comprises an intrinsic amorphous silicon layer, a doped amorphous silicon layer on the intrinsic amorphous silicon, the layer of intrinsic amorphous silicon has n layers, wherein in contact with the monocrystalline silicon substrate is a first layer, in contact with the p-type amorphous silicon layer and the n-type amorphous silicon layer is an nth layer, a ratio between hydrogen and silane



in the first layer intrinsic amorphous silicon layer is between 0: between 1 to 1: 1, a ratio between hydrogen and silane in the nth layer intrinsic amorphous silicon layer of 10: 1 to 500: Between 1, the layer of intrinsic amorphous silicon further comprising one or more intermediate layer intrinsic amorphous silicon layers located between said first layer of intrinsic amorphous silicon and said nth layer of intrinsic amorphous silicon, hydrogen and silane in each of the intermediate layer intrinsic amorphous silicon layers gradually transition in a ratio of 1: 1 to 10: 1 from the first layer intrinsic amorphous silicon layer to the nth layer intrinsic amorphous silicon layer. As can be seen, Comparative 4 discloses the same as section 74 of Specific Example of the specification, the layer of intrinsic amorphous silicon is provided as a multi-layer, and a trend of variation of the flow ratio of silane to hydrogen gas at different layers of intrinsic amorphous silicon deposition, and to work the same, and the skilled person can undoubtedly determine that Comparative Document 3 has the same hydrogen content variation of the intrinsic amorphous silicon layer close to the silicon substrate and the intrinsic amorphous silicon layer close to the doped amorphous silicon layer as in the present application, i.e. Comparative Document 4 gives corresponding technical implications. On this basis, the multilayer intrinsic amorphous silicon layer is arranged as two layers, and the arrangement of the thickness and refractive index of each layer is only a conventional arrangement.

Comparative document 4 also discloses increasing oxygen doping and/or carbon doping during coating of the p-type amorphous silicon layer and the n-type amorphous silicon layer, the ratio between oxygen doping and/or carbon doping and silane being increased from 0: 1 to 1: 1.4 from start to end of coating of the p-type amorphous silicon layer and the n-type amorphous silicon layer. As can be seen, Comparative Document 4 discloses that the doping concentration of the doped amorphous silicon close to the intrinsic amorphous silicon layer is less than the doping concentration of the doped amorphous silicon close to the transparent conductive layer during deposition of the doped amorphous silicon. And the same role, i.e. Comparative document 4 gives a corresponding technical implication. On this basis, doped amorphous silicon with gradually increasing doping concentration is provided in two layers, only in a conventional arrangement. It can be seen that the technical solutions of these claims are based on Comparative Document 1 in combination with Comparative Documents 2-4 and the above common general knowledge, it will be readily apparent to one skilled in the art that the claimed subject matter thus does not possess the outstanding essential features and significant advancements, and does not possess the inventive step set forth in clause 22, clause 3 of the patent law.

5. Claim 14 claims a method for producing a solar cell, and Comparative Document 1 (CN210443566U) discloses a method for producing a solar cell, and specifically discloses that the production of a solar cell 100 mainly comprises: providing a silicon wafer 10 for surface texturing; forming a diffusion layer 11 on the front side of the silicon wafer 10; the silicon wafer 10 has a first region and a second region, the tunneling layer 40 and the doped silicon carbide layer 50 being fabricated on the front side of the first region; an antireflection layer 60 is deposited on the surface of the doped silicon carbide layer 50 and the diffusion layer 11 of the second region, and a backside passivation layer 70 is prepared on the backside of the silicon wafer 10; corresponding pastes are printed on the front side, the back side, respectively, of the silicon wafer 10 and sintered to give a front electrode 20 penetrating the antireflection layer 60 and being in contact with the doped silicon carbide layer 50 and a back electrode 30 penetrating the back passivation layer 70 and being in contact with the silicon wafer 10. After surface cleaning, a tunneling film covering the front side of the silicon wafer 10 and a doped silicon carbide film are sequentially deposited; a corrosion resistant layer is then applied on the front side of the first region, and portions of the tunneling



film and the doped silicon carbide film at the surface of the second region are removed by etching to provide a tunneling layer 40 and a doped silicon carbide layer 50 stacked on the front side of the first region. Of course, it is also possible to prepare respective masking layers in the second region beforehand, followed by deposition of the tunneling layer 40 and the doped silicon carbide layer 50.

The solution of this claim differs from Comparative Document 1 in that the back side of the silicon substrate is provided with an intrinsic amorphous silicon layer, a doped amorphous layer and a transparent conductive layer in that order, and the back side electrode is provided on a surface of the transparent conductive layer facing away from the side of the silicon substrate. Based on the above distinctions, the technical problem to be practically solved by the technical solution of this claim is how to arrange the back electrode.

Comparative document 2 (CN109564951 A) discloses a solar cell and a method for manufacturing a solar cell, and specifically discloses (see Detailed Description, Figures 1-4): As shown in Figure 1, the back side of the silicon substrate 12 is provided with an intrinsic amorphous silicon passivation layer 15, a p-type amorphous silicon layer 16 and a transparent conductive layer 22 in this order (i.e. The back side of the silicon substrate is provided with an intrinsic amorphous silicon layer, a doped amorphous layer and a transparent conductive layer in this order), the back electrode 23 is disposed on the surface of the transparent conductive layer on the side facing away from the silicon substrate (i.e. The back electrode is disposed on the surface of the transparent conductive layer on the side facing away from the silicon substrate). And its role in Comparative Document 2 is the same as its role in Claim 1, all for providing the back electrode. That is, Comparative Document 2 gives insight to use the above-described distinguishing features for Comparative Document 1 to solve the technical problem thereof. Therefore, it will be obvious to those skilled in the art that the technical solution of this claim is derived from Comparative Document 1 in conjunction with Comparative Document 2, so that the technical solution claimed in this claim has no outstanding substantive features and significant advancements, without the inventive step specified by Article 22, Article 3 of the Patent law.

6. Claim 15 when dependent on Claim 14, and for additional technical features defining portions thereof, Comparative Document 1 has disclosed etching to remove portions of the tunneling film and doped silicon carbide film at the surface of the second region, resulting in a tunneling layer 40 and doped silicon carbide layer 50 stacked on the front side of the first region. On this basis, the skilled person choosing the slot to expose the doped polysilicon layer outwards is without inventive step and, therefore, in the event that the claim to which it is cited is not inventive, the solution of that claim does not have the inventive step specified in clause 22, paragraph 3 of the patent law.

7. Claim 16 with reference to claim 14, and for additional technical features defining parts thereof, Comparative Document 1 discloses printing respective pastes on the front side and on the back side of a silicon wafer 10, respectively, and sintering to obtain a front electrode 20 and a back electrode 30. The drying temperature can instead be selected by the person skilled in the art as the case may be. Thus, to the extent that a claim is relied upon without inventive step, the claim does not have the inventive step as set forth in clause 22, clause 3 of the patent law.

8. Claim 17 is dependent on Claim 14, and for additional technical features defining parts thereof, a person skilled in the art can select the preparation method of the doped polysilicon layer according to practical needs, the technical effect of which can be expected by a person skilled in the art. Thus, to the extent that a claim is relied upon without inventive step, the claim does not have the inventive step as set forth in clause 22, clause 3 of the patent law.



9. Claims 18, 20-23 depending on claim 14 and claim 21 depending on claim 14 or 20, Comparative Document 2 discloses, for additional technical features in defining parts thereof, a p-type amorphous silicon layer 16 thickness of 5 to 25 nm, a concentration of p-type dopants of, for example, 1×10^{20} atoms/cm³ or more; the transparent conductive layer 22 has a thickness of 30 to 500 nm; the transparent conductive layers 20, 22 are formed by, for example, a sputtering method, comparative document 3 (CN210897294U) discloses a solar cell, and in particular discloses (see specific examples of the description, Figures 1-4) that a doped polysilicon layer comprises a first portion 31 and a second portion 32, a front electrode being correspondingly arranged on the first portion 31, the doping concentration of the first portion 31 being greater than the doping concentration of the second portion 32, the doping concentration of the first portion 31 being $1\text{E}20\text{-}8\text{E}20 \text{ cm}^{-3}$; in addition, the partial etch is formed using mask etching, followed by cleaning to remove the mask after etching, annealing at 180 ° C to 220 ° C after deposition of the transparent conductive layer, and photo-injection or electro-injection after finishing the preparation of the front electrode and the back electrode, are conventional techniques. The method for laser grooving, the method for forming front and back electrodes and the method for preparing doped polysilicon are also conventional techniques. After the preparation of the antireflection layer is completed, the silicon substrate is back cleaned, leaving the tunneling layer, the doped polysilicon layer and the antireflection layer on the side of the silicon substrate, which is an adjustment of conventional techniques and does not have outstanding substantial features. Accordingly, to the extent that a claim is relied upon is not inventive, such claim is not inventive as set forth in clause 22, clause 3 of the patent law.

10. Claim 19 with reference to claim 14, for additional technical features of defined parts thereof, comparative document 4 (CN110707182A) discloses a heterojunction cell preparation method, and discloses (cf. Claims 1-13, specific examples of the description): the heterojunction passivation layer comprises an intrinsic amorphous silicon layer, a doped amorphous silicon layer on the intrinsic amorphous silicon, the layer of intrinsic amorphous silicon has n layers, wherein in contact with the monocrystalline silicon substrate is a first layer, in contact with the p-type amorphous silicon layer and the n-type amorphous silicon layer is an nth layer, a ratio between hydrogen and silane in the first layer intrinsic amorphous silicon layer is between 0: between 1 to 1: 1, a ratio between hydrogen and silane in the nth layer intrinsic amorphous silicon layer of 10: 1 to 500: Between 1, the layer of intrinsic amorphous silicon further comprising one or more intermediate layer intrinsic amorphous silicon layers located between said first layer of intrinsic amorphous silicon and said nth layer of intrinsic amorphous silicon, hydrogen and silane in each of the intermediate layer intrinsic amorphous silicon layers gradually transition in a ratio of 1: 1 to 10: 1 from the first layer intrinsic amorphous silicon layer to the nth layer intrinsic amorphous silicon layer. As can be seen, Comparative 4 discloses the same as section 74 of Specific Example of the specification, the layer of intrinsic amorphous silicon is provided as a multi-layer, and a trend of variation of the flow ratio of silane to hydrogen gas at different layers of intrinsic amorphous silicon deposition, and to work the same, and the skilled person can undoubtedly determine that Comparative Document 4 has the same hydrogen content variation of the intrinsic amorphous silicon layer close to the silicon substrate and the intrinsic amorphous silicon layer close to the doped amorphous silicon layer as in the present application, i.e. Comparative Document 4 gives corresponding technical implications.

Comparative document 4 also discloses increasing oxygen doping and/or carbon doping during coating of the p-type amorphous silicon layer and the n-type amorphous silicon layer, the ratio between oxygen doping and/or carbon doping and silane being increased from 0: 1 to 1: 1.4 from start to end of coating of the p-type amorphous silicon



layer and the n-type amorphous silicon layer. As can be seen, Comparative Document 3 discloses that the doping concentration of the doped amorphous silicon close to the intrinsic amorphous silicon layer is less than the doping concentration of the doped amorphous silicon close to the transparent conductive layer during deposition of the doped amorphous silicon. And the same role, i.e. Comparative document 4 gives a corresponding technical implication. On this basis, doped amorphous silicon with gradually increasing doping concentration is provided in two layers, only in a conventional arrangement. It can be seen that the technical solutions of these claims are based on Comparative Document 1 in combination with Comparative Documents 2-4 and the above common general knowledge, it will be apparent to one skilled in the art that Accordingly, the claimed subject matter has no outstanding material features and significant advancements, and thus, in the event that a claim hereof is relied upon without inventive step, the claimed subject matter has no inventive step as specified in clause 3 of clause 22 of patent law.

For the above reasons, none of the independent claims nor the dependent claims of the present application are inventive, at the same time, nothing other patentable material is described in the specification, such that the present application is not patentable even if the applicant recombines the claims and/or further defines them based on what is described in the specification. If Applicant is unable to propose a sufficient reason to suggest that the application is inventive, within the answering date set forth in this written description, the application will be dismissed.

In case of doubt for the examination, feedback may be performed by: (1) this case Examiner phone 027-59182751; (2) a central quality supervision mailbox hbzxywzx @ cnipa.gov.cn; (3) Central review business advisory phone 027-59371999. Opinion statements and/or modified texts fed back through the quality supervisory mailbox are not legally valid and cannot replace formal replies.

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