



(51) International Patent Classification:
H01B 1/20 (2006.01) *H01L 31/042* (2006.01)

(21) International Application Number:
PCT/KR2010/005957

(22) International Filing Date:
2 September 2010 (02.09.2010)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
10-2009-0082712
2 September 2009 (02.09.2009) KR

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(81) Designated States (unless otherwise indicated, for every kind of national protection available): AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PE, PG, PH, PL, PT, RO, RS, RU, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

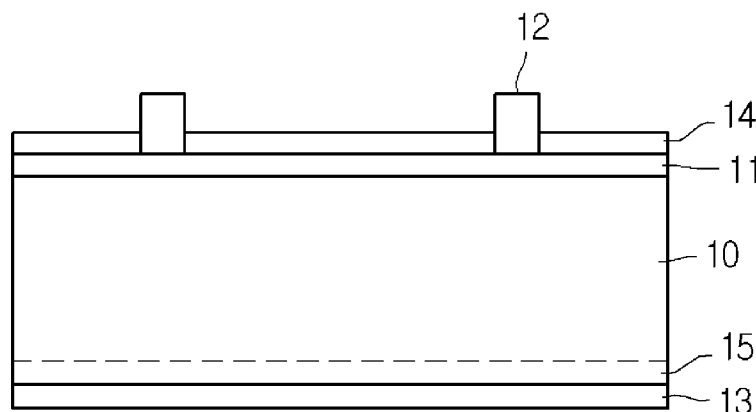
(84) Designated States (unless otherwise indicated, for every kind of regional protection available): ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:

— without international search report and to be republished upon receipt of that report (Rule 48.2(g))

(54) Title: DOPANT DIFFUSION SOLUTION, PASTE COMPOSITION FOR ELECTRODE, AND METHOD OF FORMING DOPING AREA

[Fig. 1]



(57) Abstract: A dopant diffusion solution according to the embodiment includes an organic solvent and a compound including a group III dopant or a group V dopant.

Description

Title of Invention: DOPANT DIFFUSION SOLUTION, PASTE COMPOSITION FOR ELECTRODE, AND METHOD OF FORMING DOPING AREA

Technical Field

- [1] The disclosure relates to a dopant diffusion solution, a paste composition for an electrode of a solar cell using the same and a method of forming a doping area of the solar cell.

Background Art

- [2] Recently, the development of next generation clean energy has become more important due to the lack of fossil fuel. Among the next generation clean energy, a solar cell is spotlighted as an energy source for solving the future energy problem because it rarely causes environmental pollution and has the semi-permanent life span and there exists infinite resources for the solar cell.
- [3] Such a solar cell can be manufactured by forming a top electrode and a rear electrode on a silicon substrate having an N type semiconductor (emitter) and a P type semiconductor (back surface field (BSF) layer). In the solar cell, it is very important to improve the photoelectronic transformation efficiency by forming the emitter, the BSF layer, and the electrodes through a simple process such that they have superior characteristics.

Disclosure of Invention

Technical Problem

- [4] The embodiment provides a dopant diffusion solution capable of improving the efficiency of a solar cell while simplifying a process of forming the solar cell, a paste composition for an electrode of the solar cell using the same and a method of forming a doping area of the solar cell.

Solution to Problem

- [5] A dopant diffusion solution according to the embodiment includes an organic solvent; and a compound including a group III dopant or a group V dopant.
- [6] The group III dopant may include at least one selected from the group consisting of boron, aluminum, gallium, indium, and thallium. The group V dopant may include at least one selected from the group consisting of phosphorus, nitrogen, arsenic, antimony, and bismuth. The organic solvent may include a volatile solvent.
- [7] The dopant diffusion solution can be used in a paste composition for an electrode of a solar cell. In addition, the dopant diffusion solution including the group V dopant can

be used to form an emitter of the solar cell and the dopant diffusion solution including the group III dopant can be used to form a BSF (back surface field) layer of the solar cell.

- [8] A paste composition for an electrode of a solar cell according to the embodiment includes metal powder; and a dopant diffusion solution. The dopant diffusion solution includes an organic solvent and a compound including a group III dopant or a group V dopant.
- [9] An amount of the dopant diffusion solution is about 2 to 12 wt% based on a total amount of the paste composition. Preferably, the amount of the dopant diffusion solution is about 4 to 6 wt% based on the total amount of the paste composition.
- [10] The group III dopant may include at least one selected from the group consisting of boron, aluminum, gallium, indium, and thallium. The group V dopant includes at least one selected from the group consisting of phosphorus, nitrogen, arsenic, antimony, and bismuth. The organic solvent may include a volatile solvent.
- [11] The paste composition further includes an organic vehicle, and the dopant diffusion solution is included in the organic vehicle. The paste composition further includes an organic vehicle and an additive, and the dopant diffusion solution is included in the additive.
- [12] A method of forming a doping area of a solar cell according to the embodiment includes the steps of preparing a dopant diffusion solution including an organic solvent and a compound having a group III dopant or a group V dopant on a substrate; and thermally the group III dopant or the group V dopant into the substrate.
- [13] The dopant diffusion solution can be prepared on the substrate by dipping the substrate in the dopant diffusion solution or coating the dopant diffusion solution on the substrate.
- [14] The dopant diffusion solution including the group V dopant can be used to form an emitter of the solar cell. The dopant diffusion solution including the group V dopant can be used to form a BSF (back surface field) layer of the solar cell.
- [15] The step of preparing the dopant diffusion solution on the substrate may include the steps of coating an N type diffusion solution including the group V dopant on a first surface of the substrate, coating a P type diffusion solution including the group III dopant on a second surface of the substrate, and thermally the group III dopant and the group V dopant into the substrate, thereby forming the emitter and the BSF layer, respectively.

Advantageous Effects of Invention

- [16] The dopant diffusion solution according to the embodiment includes an organic solvent as well as a group III dopant or a group V dopant, so the dopant diffusion

solution may have the hydrophobic property. Thus, the dopant in the dopant diffusion solution can be easily diffused in a hydrophobic silicon substrate.

[17] When the dopant diffusion solution according to the embodiment is employed to form the emitter of the solar cell, the process can be simplified and the dopant can be uniformly diffused through the dipping and coating.

[18] In addition, when the dopant diffusion solution according to the embodiment is employed to preliminarily form the BSF layer of the solar cell, the thickness of the rear electrode can be reduced, and the bowing of the solar cell can be prevented. As a result, the life span of the solar cell can be lengthened.

[19] The emitter and the BSF layer can be simultaneously formed by drying the N type diffusion solution coated on one surface of the silicon substrate, drying the P type diffusion solution coated on the other surface of the silicon substrate, and then performing the thermal diffusion process. Therefore, the process can be simplified and the emitter and the BSF layer may have superior characteristics.

[20] When the paste composition including the dopant diffusion solution according to the embodiment is employed to form the electrode of the solar cell, the high-concentration doping area can be formed, so that the potential difference in the solar cell can be improved. Thus, open circuit voltage (Voc) of the solar cell can be improved, so the efficiency of the solar cell can be enhanced.

Brief Description of Drawings

[21] FIG. 1 is a sectional view of a solar cell;

[22] FIG. 2 is a graph showing the BSF ratio according to the content of the diffusion solution; and

[23] FIG. 3 is a graph showing the BSF thickness according to the content of the diffusion solution.

Best Mode for Carrying out the Invention

[24] Hereinafter, a dopant diffusion solution, a paste composition for an electrode of the solar cell using the same and a method of forming a doping area of the solar cell according to the embodiment will be described in detail.

[25] The dopant diffusion solution according to the embodiment includes a compound having a group III dopant or a group V dopant and a compound having an organic solvent.

[26] If the dopant diffusion solution includes a compound having a group III dopant, the dopant diffusion solution may serve as a P type diffusion solution. Such a compound may be oxide or nitride including at least one or two selected from the group consisting of boron, aluminum, gallium, indium, and thallium, which are the group III dopant.

[27] The amount of the compound including the group III dopant may be 0.1 to 5wt%

based on the total amount of the dopant diffusion solution. If the amount of the compound exceeds 5wt%, the electric conductivity is degraded. In contrast, if the amount of the compound is less than 0.1wt%, the diffusion characteristic is deteriorated.

- [28] If the dopant diffusion solution includes a compound having a group V dopant, the dopant diffusion solution may serve as an N type diffusion solution. Such a compound may be oxide or nitride including at least one or two selected from the group consisting of phosphorus, nitrogen, arsenic, antimony, and bismuth, which are the group V dopant.
- [29] The amount of the compound including the group V dopant may be 0.1 to 5wt% based on the total amount of the dopant diffusion solution. If the amount of the compound exceeds 5wt%, the electric conductivity is degraded. In contrast, if the amount of the compound is less than 0.1wt%, the diffusion characteristic is deteriorated.
- [30] The organic solvent may be volatilized in the subsequent process such that the dopant can be uniformly present. In this regard, the organic solvent may include a volatile solvent. Preferably, the organic solvent may include a volatile solvent having a low boiling point. Such a volatile solvent may include alcohol or acetone.
- [31] The N type diffusion solution may include an amine-based solution, such as oleyl amine, triethanol amine, or trioctyl amine.
- [32] The dopant diffusion solution according to the embodiment can be used to form the electrode of the solar cell or the doping area. Hereinafter, an example of a solar cell employing the dopant diffusion solution according to the embodiment will be described. FIG. 1 is a sectional view of the solar cell.
- [33] Referring to FIG. 1, the solar cell includes a P type silicon substrate 10 provided on the top surface thereof with an N type semiconductor 11 (hereinafter, referred to as emitter), a top electrode 12 electrically connected to the emitter 11 and a rear electrode 13 electrically connected to the P type silicon substrate 10. An anti-reflective layer 14 can be formed on the top surface of the emitter 11 except for an area where the top electrode 12 is formed. In addition, a BSF layer 15 is formed on the rear electrode 13 of the silicon substrate 10.
- [34] The dopant diffusion solution according to the embodiment can be used to form the doping area, such as the emitter 11 and/or the BSF layer 15 of the solar cell, or the electrode, such as the top electrode 12 or the rear electrode 13.
- [35] Hereinafter, the method of forming the doping area by using the dopant diffusion solution will be described in detail.
- [36] As described above, the dopant diffusion solution may include the organic solvent and the compound including the group III dopant or the group V dopant. In addition,

an inorganic additive can be added to the dopant diffusion solution to improve the diffusion characteristic of the dopant in such a manner that the diffusion can be easily performed even if the heat treatment temperature is low or the heat treatment time is short. Such an inorganic additive may include Sc_2O_3 , Ti_2O_3 , Ni, Cu, ScO_5 , and the like.

- [37] If the dopant diffusion solution is the N type diffusion solution including the compound having the group V dopant, the emitter 11 can be formed by using the dopant diffusion solution. That is, the silicon substrate 10 is dipped in the N type diffusion solution or the N type diffusion solution is coated on one surface of the silicon substrate, and then the drying process and the thermal diffusion process are performed to form the emitter 11.
- [38] The N type diffusion solution can be coated on one surface of the silicon substrate 10 through the spin coating, evaporation, offset printing, screen printing or pad printing.
- [39] In addition, various drying methods can be used. For instance, a belt type hot dry oven, an infrared oven, or a box type oven can be utilized. The drying temperature is about 150 to 250, and the drying time is 2 to 3 minutes, but the embodiment is not limited thereto.
- [40] Further, various thermal diffusion processes can be employed to diffuse the dopant contained in the N type diffusion solution into the silicon substrate 10.
- [41] For instance, the thermal diffusion process can be performed under the temperature of 800 to 1000 for 50 seconds to 3 minutes. If the process condition exceeds the above range, bad influence is exerted upon the surface of the silicon substrate 10. In addition, if the process condition is less than the above range, the dopant may be insufficiently diffused, but the embodiment is not limited thereto.
- [42] According to the embodiment, the emitter 11 can be formed through the dipping process or the coating process. Therefore, the process time can be shortened as compared with the conventional method using phosphorus-containing gas and the process can be simplified because belt type equipment can be utilized. In addition, the dopant can be uniformly diffused as compared with the conventional method using phosphorus-containing gas.
- [43] According to the embodiment, the dopant diffusion solution includes the organic solvent, so the dopant diffusion solution has the hydrophobic property. Thus, the dopant diffusion solution can be easily formed on the hydrophobic silicon substrate 10. According to the related art, a porous layer is formed on the silicon substrate 10 as the phosphorus-containing compound is injected into the silicon substrate 10 due to hydrophilic property of the phosphorus-containing compound. In this regard, the embodiment can simplify the process as compared with the related art. In addition, according to the related art, the hardness of the silicon substrate 10 may be lowered due to the porous layer, so the silicon substrate 10 may be broken during the process.

The embodiment can prevent the above problem.

- [44] In addition, when the dopant diffusion solution is the P type diffusion solution including the compound having the group III dopant, the BSF layer 15 can be formed by using the dopant diffusion solution. That is, the silicon substrate 10 is dipped in the P type diffusion solution or the P type diffusion solution is coated on one surface of the silicon substrate 10. Then, the drying process and the thermal diffusion process are performed to form the BSF layer 15. It is more preferred to coat the P type diffusion solution on one surface of the silicon substrate 10.
- [45] The coating, drying and thermal diffusing processes of the P type diffusion solution are similar to those of the N type diffusion solution, so the detailed description thereof will be omitted to avoid redundancy. The thermal diffusion temperature of the P type diffusion solution is about 850 to 1100, which is slightly higher than that of the N type diffusion solution.
- [46] When the BSF layer 15 is previously formed before the rear electrode 13 is formed by using the dopant diffusion solution according to the embodiment, the thickness of the rear electrode 13 can be reduced and the bowing of the solar cell can be prevented. In more detail, according to the related art, the bowing of the solar cell may occur during the baking and cooling processes for forming the rear electrode 13 due to the difference in the thermal expansion coefficient between the material for the rear electrode 13 and the silicon substrate 10. Such a bowing may become severe as the thickness of the rear electrode 13 is thickened. According to the embodiment, the thickness of the rear electrode 13 can be reduced, so that the bowing of the solar cell can be prevented. Therefore, the crack caused by the bowing phenomenon may not occur in the solar cell, so that the life span of the solar cell can be lengthened.
- [47] The emitter 11 and the BSF layer 15 can be simultaneously formed by drying the N type diffusion solution coated on one surface of the silicon substrate 10, drying the P type diffusion solution coated on the other surface of the silicon substrate 10, and then performing the thermal diffusion process. Therefore, the process can be simplified and the emitter 11 and the BSF layer 15 may have superior characteristics.
- [48] However, the embodiment is not limited to the above. If it is necessary to thicken the BSF layer 15 more than the emitter 11, the thermal diffusion process for the P type diffusion solution is performed after the thermal diffusion process for the N type diffusion solution has been performed.
- [49] Hereinafter, the method of using the dopant diffusion solution in the paste composition for the electrode of the solar cell according to the embodiment will be described in detail.
- [50] The paste composition includes metal powder and the dopant diffusion solution. The paste composition may include an organic vehicle, an organic or inorganic additive,

and a glass frit. In addition, the dopant diffusion solution may be included in the organic vehicle or the additive.

- [51] The metal powder may include silver powder or aluminum powder having light weight and superior conductivity. If the metal powder includes the silver powder, the paste composition is used to form the top electrode 12. In addition, if the metal powder includes the aluminum powder, the paste composition is used to form the rear electrode 13, but the embodiment is not limited thereto.
- [52] The metal powder may have a spherical shape, a plate shape, a bell shape or a flake shape. The metal powder may consist of particles having the same shape or different shapes.
- [53] The mean grain size of the metal powder is about 1.5 to 10. If the mean grain size is less than 1.5, the organic substance may not penetrate into the metal powder due to the cohesion of the metal powder so that the metal powder may not be easily dispersed. In addition, if the mean grain size exceeds 10, many pores are formed in the metal powder, so the density of the metal powder is lowered and electric resistance of the electrode is increased.
- [54] The organic vehicle allows the paste composition to have viscosity and rheological property adapted to be coated on the silicon substrate.
- [55] The organic vehicle may include a solvent and a polymer dissolved in the solvent. In addition, the organic vehicle may include a thixotropic agent, a leveling agent, and an anti-foaming agent. The organic vehicle may also include the dopant diffusion solution.
- [56] The polymer may include acrylate resin, ethylcellulose, nitrocellulose, polymer of ethylcellulose and phenol resin, wood rosin, and polymethacrylate of alcohol.
- [57] The solvent may include at least one selected from the group consisting of butylcarbitolacetate, butylcarbitol, butylcellosolve, butylcellosolveacetate, propyleneglycolmonomethylether, dipropyleneglycolmonomethylether, propyleneglycolmonomethylpropionate, ethyletherpropionate, terpeneol, propyleneglycolmonomethyletheracetate, dimethylamino, formaldehyde, methylethylketone, gamma-butyrolactone, ethyllactate, texanol.
- [58] The thixotropic agent may include urea type, amide type or urethane type polymer/organic substance or inorganic silica.
- [59] Various materials can be used for the glass frit. For instance, lead borosilicate glass having the softening point of 400 to 600, lead silicate glass, bismuth glass or lithium glass can be used as the glass frit. In more detail, the glass frit may include at least one or two selected from the group consisting of Bi_2O_3 , B_2O_3 , SiO_2 , Al_2O_3 , CdO , CaO , BaO , ZnO , Na_2O , Li_2O , PbO , and ZrO . In addition, the glass frit has the grain size of about 1 to 10.

- [60] The paste composition according to the embodiment may further include various additives to improve the desired characteristics thereof. For instance, the paste composition may further include sintering additive, thickener, stabilizer, or surfactant. In addition, the paste composition may include the dopant diffusion solution.
- [61] For instance, the solar cell may include 60 to 95 wt% of the metal powder, 0.3 to 15 wt% of the glass frit, 4 to 39 wt% of the organic vehicle, and 0.1 to 12 wt% of the additive.
- [62] If the amount of the metal powder exceeds 95 wt%, the composition may not be prepared in the form of paste. If the amount of the metal powder is less than 60 wt%, the amount of conductive material is reduced, so that the resistance of the rear electrode may be increased. That is, when the solar cell has the above composition ratio, sinterability of the paste composition can be improved and the efficiency of the solar cell can be improved.
- [63] If the amount of the glass frit is in the range of 0.3 to 15 wt%, adhesive property, sinterability and characteristics of the post-process of the solar cell can be improved.
- [64] If the amount of the organic vehicle exceeds 39 wt%, the amount of the metal powder is reduced, so that the resistance of the electrode may be increased, thereby degrading the efficiency of the solar cell. In addition, if the amount of the organic vehicle is less than 4 wt%, the metal powder may not be easily mixed and distributed. In this case, the metal powder may not be coated on the substrate. As a result, the precision of patterns of the electrode formed by using the paste composition may be degraded.
- [65] If the amount of the additive exceeds 12 wt%, the amount of the metal powder is reduced, so that the resistance of the rear electrode may be increased, thereby degrading the efficiency of the solar cell. In addition, if the amount of the additive is less than 0.1 wt%, the effect derived from the additive may be degraded.
- [66] According to the embodiment, the dopant diffusion solution is included in the organic vehicle and/or the additive of the paste composition. That is, the dopant diffusion solution can be included in the organic vehicle of the paste composition and/or the dopant diffusion solution can be included in the paste composition separately from the organic vehicle.
- [67] In this case, the amount of the dopant diffusion solution is about 2 to 12 wt% based on the total amount of the paste composition. If the amount of the dopant diffusion solution exceeds 12 wt%, the amount of the metal powder is reduced, so that the resistance of the electrode may be lowered, thereby degrading the efficiency of the solar cell. In addition, if the amount of the dopant diffusion solution is less than 2 wt%, the amount of the dopant is insufficient, so that the efficiency of the solar cell may be degraded.

- [68] In order to further improve the resistance characteristic of the electrode formed by using the paste composition, 4 to 6 wt% of the dopant diffusion solution is added based on the total amount of the paste composition.
- [69] If the top electrode 12 is formed by using the paste composition including the N type diffusion solution according to the embodiment, the content of the group V dopant is increased, so that a heavily doped N++ region can be formed at a peripheral area of the top electrode 12. Therefore, the potential difference in the solar cell can be improved, so that the open circuit voltage Voc can be improved and the efficiency of the solar cell can be enhanced.
- [70] In addition, if the rear electrode 13 is formed by using the paste composition including the P type diffusion solution according to the embodiment, the content of the group III dopant is increased, so that the thickness of the BSF layer 15 can be enlarged. Further, the group III dopant is added as a liquid phase, other than a solid phase, so that the distribution of the paste composition can be improved. Thus, the BSF layer 15 can be uniformly formed. Accordingly, the potential difference in the solar cell can be improved, so that the open circuit voltage Voc can be improved and the efficiency of the solar cell can be enhanced.
- [71] The following examples are prepared for illustrative purposes and the embodiment is not limited to such examples.
- [72] Example 1
- [73] The paste composition was prepared by adding the P type diffusion solution to the composition including 70 wt% of aluminum powder, 3 wt% of the glass frit, and 27 wt% of the organic vehicle. The amount of the P type diffusion solution was 2 wt% based on the total amount of the paste composition. The P type diffusion solution was prepared by dissolving boric acid in acetone. The a ratio of boric acid : acetone was 30:70 by wt%.
- [74] Example 2
- [75] Example 2 is similar to Example 1 except that the amount of the P type diffusion solution was 4 wt% based on the total amount of the paste composition.
- [76] Example 3
- [77] Example 3 is similar to Example 1 except that the amount of the P type diffusion solution was 6 wt% based on the total amount of the paste composition.
- [78] Example 4
- [79] Example 4 is similar to Example 1 except that the amount of the P type diffusion solution was 8 wt% based on the total amount of the paste composition.
- [80] Example 5
- [81] Example 5 is similar to Example 1 except that the amount of the P type diffusion solution was 10 wt% based on the total amount of the paste composition.

[82] Example 6

[83] Example 6 is similar to Example 1 except that the amount of the P type diffusion solution was 12 wt% based on the total amount of the paste composition.

[84] Comparative Example

[85] The paste composition was prepared by adding solid-phase B_2O_3 to the composition including 70 wt% of aluminum powder, 3 wt% of the glass frit, and 27 wt% of the organic vehicle. The amount of the solid-phase B_2O_3 was 2 wt% based on the total amount of the paste composition.

[86]

[87] The rear electrode was formed by coating the paste composition of Examples 1 to 6 and Comparative Example on the silicon substrate and then drying the paste composition. In this state, the thickness of the BSF layer, the surface resistance of the rear electrode, the thickness of the rear electrode, the BSF ratio (BSF thickness/electrode thickness), and the surface resistance ratio (surface resistance/rear electrode thickness) were measured. For the purpose of precision of experiment, the electrode was prepared three times by using the same paste composition. The result is shown in Table 1. The BSF ratio according to the content of the diffusion solution is shown in FIG. 2, and the BSF thickness according to the content of the diffusion solution is shown in FIG. 3.

[88] Table 1

[Table 1]

	thickness of BSF [μm]				surface resistance of rear electrode [$m\Omega/\square$]				thickness of rear electrode [μm]				BSF ratio	surface resistance ratio
	1	2	3	mean	1	2	3	mean	1	2	3	mean	-	-
Example 1	3.71	30.7	3.3	3.36	12.17	11.96	11.87	12.00	25.86	24.75	25.57	25.39	0.132	0.473
Example 2	3.54	3.71	3.71	3.65	9.97	9.43	9.45	9.62	23.83	23.88	21.8	23.17	0.157	0.415
Example 3	3.94	2.78	3.71	3.48	9.91	10.32	10.44	10.22	18.9	20.7	18.9	19.50	0.178	0.524
Example 4	3.54	3.65	4.17	3.79	10.54	10.88	11.02	10.81	25.22	23.01	24.4	24.21	0.156	0.447
Example 5	3.25	3.52	3.42	3.39	9.64	9.82	9.86	9.77	23.85	22.74	22.69	23.09	0.147	0.423
Example 6	3.48	4.12	3.19	3.60	11.49	11.50	11.46	11.48	22.84	22.61	22.09	22.51	0.160	0.510
Comparative example	2.32	2.34	2.49	3.55	15.17	14.75	13.14	14.35	28.64	27.94	26.26	27.61	0.092	0.520

[89]

[90] Referring to Table 1, Examples 1 to 6 represent superior characteristics in terms of the BSF ratio and the surface resistance ratio as compared with the Comparative Example. For reference, if the thickness of the rear electrode is increased, the thickness of the BSF layer is increased and the surface resistance is reduced. Thus, it is preferred to compare the characteristics based on the BSF ratio and the surface resistance ratio. In particular, in the cases of Examples 2 and 3 (that is, the amount of diffusion solution is 4 to 6 wt%), the characteristics of the BSF ratio and the surface resistance ratio are improved. In addition, referring to FIGS. 2 and 3, if the amount of diffusion solution is

about 6 wt% or more, the characteristics of the BSF ratio and the surface resistance ratio are not improved any more, but maintained constantly.

Industrial Applicability

[91] The embodiments are applicable to the solar cell and the dopant paste solution.

[92]

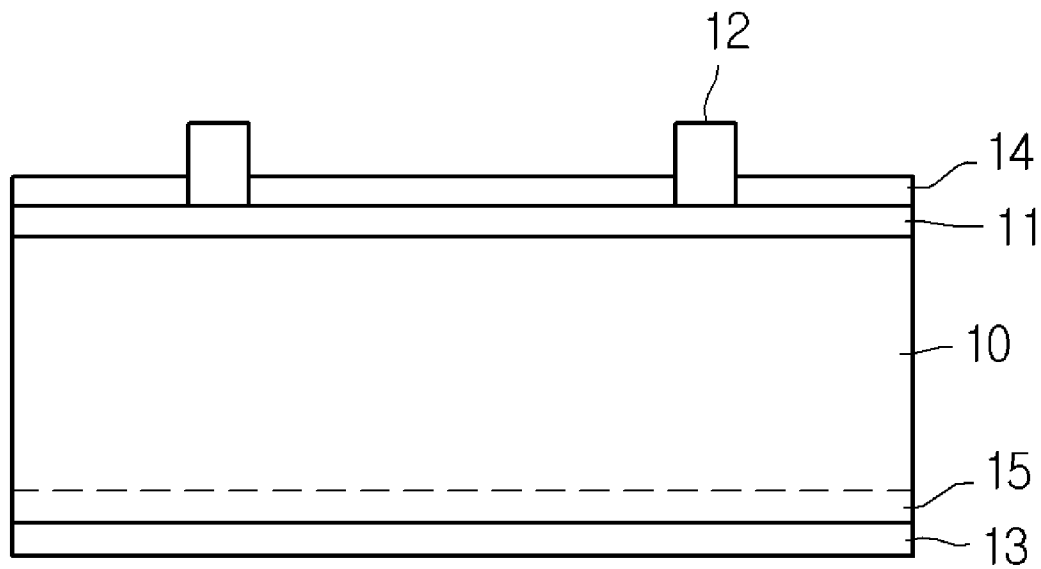
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Claims

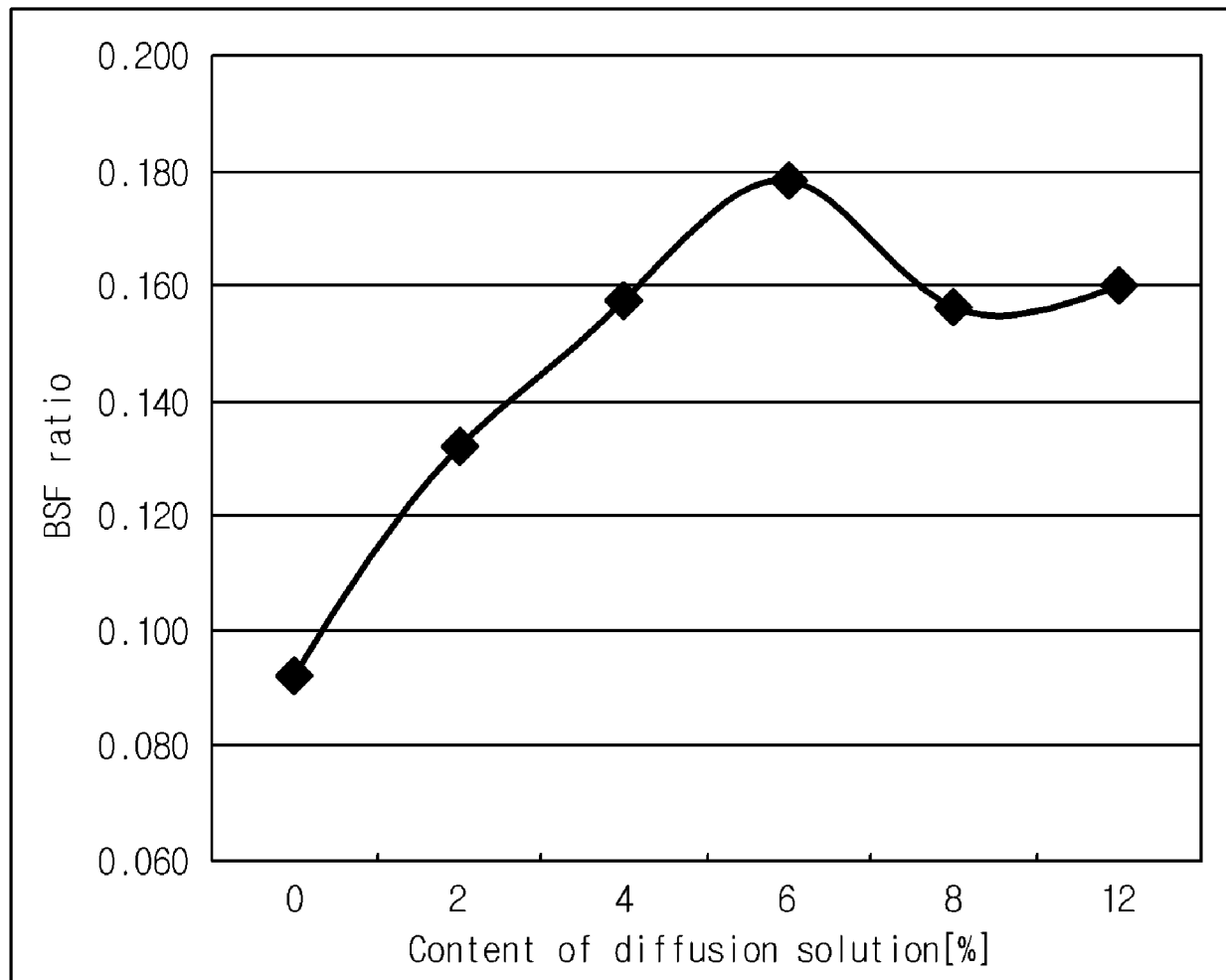
- [Claim 1] A dopant diffusion solution comprising:
an organic solvent; and
a compound including a group III dopant or a group V dopant.
- [Claim 2] The dopant diffusion solution of claim 1, wherein the group III dopant includes at least one selected from the group consisting of boron, aluminum, gallium, indium, and thallium.
- [Claim 3] The dopant diffusion solution of claim 1, wherein the group V dopant includes at least one selected from the group consisting of phosphorus, nitrogen, arsenic, antimony, and bismuth.
- [Claim 4] The dopant diffusion solution of claim 1, wherein the organic solvent includes a volatile solvent.
- [Claim 5] The dopant diffusion solution of claim 1, wherein the dopant diffusion solution is used in a paste composition for an electrode of a solar cell.
- [Claim 6] The dopant diffusion solution of claim 1, wherein the dopant diffusion solution including the group V dopant is used to form an emitter of a solar cell.
- [Claim 7] The dopant diffusion solution of claim 1, wherein the dopant diffusion solution including the group III dopant is used to form a BSF (back surface field) layer of a solar cell.
- [Claim 8] A paste composition for an electrode of a solar cell, the paste composition comprising:
metal powder; and
a dopant diffusion solution including an organic solvent and a compound including a group III dopant or a group V dopant.
- [Claim 9] The paste composition of claim 8, wherein an amount of the dopant diffusion solution is about 2 to 12 wt% based on a total amount of the paste composition.
- [Claim 10] The paste composition of claim 9, wherein the amount of the dopant diffusion solution is about 4 to 6 wt% based on the total amount of the paste composition.
- [Claim 11] The paste composition of claim 8, wherein the group III dopant includes at least one selected from the group consisting of boron, aluminum, gallium, indium, and thallium.
- [Claim 12] The paste composition of claim 8, wherein the group V dopant includes at least one selected from the group consisting of phosphorus, nitrogen, arsenic, antimony, and bismuth.

- [Claim 13] The paste composition of claim 8, wherein the organic solvent includes a volatile solvent.
- [Claim 14] The paste composition of claim 8, further comprising an organic vehicle, wherein the dopant diffusion solution is included in the organic vehicle.
- [Claim 15] The paste composition of claim 8, further comprising an organic vehicle and an additive, wherein the dopant diffusion solution is included in the additive.
- [Claim 16] A method of forming a doping area of a solar cell, the method comprising:
preparing a dopant diffusion solution including an organic solvent and a compound having a group III dopant or a group V dopant on a substrate; and
thermally the group III dopant or the group V dopant into the substrate.
- [Claim 17] The method of claim 16, wherein the dopant diffusion solution is prepared on the substrate by dipping the substrate in the dopant diffusion solution or coating the dopant diffusion solution on the substrate.
- [Claim 18] The method of claim 16, wherein the dopant diffusion solution including the group V dopant is used to form an emitter of the solar cell.
- [Claim 19] The method of claim 16, wherein the dopant diffusion solution including the group V dopant is used to form a BSF (back surface field) layer of the solar cell.
- [Claim 20] The method of claim 16, wherein the preparing of the dopant diffusion solution on the substrate includes:
coating an N type diffusion solution including the group V dopant on a first surface of the substrate;
coating a P type diffusion solution including the group III dopant on a second surface of the substrate; and
thermally the group III dopant and the group V dopant into the substrate, thereby forming an emitter and a BSF (back surface field) layer, respectively.

[Fig. 1]



[Fig. 2]



[Fig. 3]

