Claims

1. A method for the processing of a device, having a crystalline silicon region containing an internal hydrogen source, the method comprising

i) applying encapsulating material to each of the front and rear surfaces of the device to form a lamination;

ii) applying pressure to the lamination and heating the lamination ~~under illumination~~ to bond the encapsulating material to the device whilst simultaneously actively injecting minority carriers in the crystalline silicon region.

2. The method of claim 1 wherein ~~the device is also illuminated~~ minority carriers are actively injected during a cooling step following the heating step.

3. A method for the processing of a device, having a crystalline silicon region containing an internal hydrogen source, the method comprising

i) applying encapsulating material to each of the front and rear surfaces of the device to form a lamination;

ii) applying pressure to the lamination and heating the lamination to bond the encapsulating material to the device;

iii) cooling the device ~~under illumination~~ whilst simultaneously actively injecting minority carriers in the crystalline silicon region.

4. The method of claim 3 wherein minority carriers are injected into the device ~~is also illuminated~~ during the heating step.

5. The method as claimed in any one of claims 1 to 4 wherein the crystalline silicon region containing the hydrogen source comprises atomic hydrogen contained interstitially within the crystalline silicon of the crystalline silicon region.

6. The method as claimed in any one of claims 1 to 5 wherein the crystalline silicon region containing the hydrogen source comprises a doped crystalline silicon region in which some of the dopant atoms are deactivated by combining with a hydrogen atom.

7. The method as claimed in claim 6 wherein while the crystalline silicon region is at an elevated temperature, some of the deactivated dopant atoms are reactivated by ~~illuminating~~ injecting minority carriers into the doped crystalline silicon region.

8. The method as claimed in claim 6 wherein the encapsulating material comprises a bonding

sheet applied to each surface of the device and a glass sheet over each bonding sheet and the step of applying pressure and heating causes the bonding sheets to bond to the respective the glass sheet and the respective surface of the device.

9. The method of claim 8 wherein each bonding sheet is a sheet of ethylene vinyl acetate (EVA) material.

10. The method as claimed in any one of the preceding claims wherein the doped crystalline silicon region is a surface region of the device.

11. The method as claimed in any one of the preceding claims wherein hydrogen is introduced into the crystalline silicon region by forming a dielectric hydrogen source on a surface of the crystalline silicon region and subsequently heating the device to migrate the hydrogen into the crystalline silicon region.

12. The method as claimed in claim 11 wherein hydrogen is introduced into the crystalline silicon region from the dielectric hydrogen source to deactivate dopant atoms in the crystalline silicon region, by heating the device in the absence of illumination or in low illumination conditions.

13. The method as claimed in claim 12 wherein dielectric hydrogen sources are formed on each of the front and rear surfaces of the device.

14. The method as claimed in any one of claims 12 or 13 wherein the dielectric hydrogen source comprises layers of one or more of silicon nitride, amorphous silicon, silicon oxynitride, aluminium oxides.

15. The method as claimed in any one of claims 12, 13 or 14 wherein the device comprises a silicon surface n-type diffused layer through which hydrogen must diffuse and the silicon surface n-type diffused layer has a net active doping concentration of $1x10^{20}$ atoms/cm^3 or less.

16. The method as claimed in any one of claims 12, 13, 14 or 15 wherein the device comprises a silicon surface diffused p-type layer through which hydrogen must diffuse and the silicon surface diffused p-type layer has a net active doping concentrations of $1x10^{19}$ atoms/cm^3 or less.

17. The method of any one of the preceding claims, wherein injecting minority carriers comprise illuminating the crystalline silicon region.

~~17~~18. The method as claimed in ~~any one of the preceding claims~~ claim 17 wherein the heating of the device comprises heating at least a region of the device to at least 40°C while simultaneously illuminating at least some of the device with at least one light source whereby the cumulative power of all the incident photons with sufficient energy to generate electron hole pairs within silicon is at least 20mW/cm^2.

~~18~~19. The method as claimed in ~~any one of the preceding claims~~claim 17 wherein the illumination of the device is from at least one light source and is provided at a level whereby the cumulative power of all the incident photons with sufficient energy to generate electron hole pairs within silicon is at least 50 mW/cm^2, or 60 mW/cm^2, or 70 mW/cm^2, or 80 mW/cm^2, or 90 mW/cm^2, or 100 mW/cm^2, or 150 mW/cm^2, 200 mW/cm^2, or 300 mW/cm^2, or 400 mW/cm^2, or 500 mW/cm^2, or 600 mW/cm^2, or 700 mW/cm^2, or 800 mW/cm^2, or 900 mW/cm^2, or 1000 mW/cm^2, or 1500 mW/cm^2, 2000 mW/cm^2, or 3000 mW/cm^2, or 5000 mW/cm^2, or 10000 mW/cm^2, or 15000 mW/cm^2, or 20000 mW/cm^2, or up to a light intensity at which crystalline silicon begins to melt.

~~19~~20. The method as claimed in any one of the preceding claims wherein for each of the ranges of cumulative power, the heating of the device comprises heating at least a region of the device to at least 100°C, to at least 140°C, or to at least 150°C, or to at least 180°C, or to at least 200 °C.

~~20. The method as claimed in any one of the preceding claims wherein heating of the device comprises heating the device to at least 140°C.~~

~~21. The method as claimed in any one of the preceding claims wherein heating of the device comprises heating the device to at least 150°C.~~

~~22. The method as claimed in any one of the preceding claims wherein heating of the device comprises heating the device to at least 180°C.~~

~~23. The method as claimed in any one of the preceding claims wherein heating of the device comprises heating the device to at least 200 °C.~~

~~24~~21. The method as claimed in any one of the preceding claims wherein heating of the device is followed by cooling the device while simultaneously illuminating at least some of the device with at least one light source whereby the cumulative power of all the incident photons with sufficient energy to generate electron hole pairs within silicon is at least 20mW/cm^2.

~~25~~22. The method as claimed in claim 17~~any one of the preceding claims~~ wherein a source of illumination applied to the device is an array of LEDs or one or more infra-red lamps.

~~26. The method as claimed in any one of claims 1 to 20 wherein a source of illumination applied to the device is one or more infra-red lamps.~~

~~27~~23. The method as claimed in ~~any one of the preceding claims~~claim 17 wherein the illumination applied to the device is pulsed.

~~28~~24. The method as claimed in ~~any one of the preceding claims~~claim 17 wherein the intensity of illumination applied to the device is controlled to maintain the Fermi level at a value of 0.10 to 0.22ev above mid-gap.

~~29~~25. The method as claimed in any one of the preceding claims wherein the device comprises a photovoltaic device having at least one rectifying junction.

~~30~~26. The method as claimed in any one of the preceding claims wherein the doped crystalline silicon region is doped with a p-type (valency 3) dopant selected from boron, aluminium or gallium.

~~31~~27. The method as claimed in ~~any one of~~ claim~~s 1 to~~ 26 wherein the doped crystalline silicon region is doped with boron.

~~32~~28. The method as claimed in any one of the preceding claims wherein the doped crystalline silicon region is doped with an n-type (valency 3) dopant.

~~33~~29. The method as claimed in ~~any one of~~ claim~~s 1 to~~ 28 wherein the doped crystalline silicon region is doped with phosphorus.

~~34~~30. The method as claimed in any one of claims 1 to ~~26~~25 wherein the doped crystalline silicon region is doped with boron and phosphorus.