see back side silicon nitride film **305** and front side silicon nitride film **304**. At both sides electrodes **306**, **307** are manufactured. As compared to the solar cell of FIG. **1**, in between the substrate **301** and the silicon nitride films **304**, **305**, in situ thermal oxide layers **308**, **309** are formed.

[0039] FIG. **4** shows a flow chart of a manufacturing process of Group B. The specific process condition at each process step is as follows.

[0040] step **401**: same as step **201**.

[0041] step **402**: same as step **202**.

[0042] step **403**: same as step **203**.

[0043] step **404**: same as step **204**.

[0044] In step **405** a 20 nm silicon oxide film is grown using a thermal oxidation process by heating the substrate in a tube furnace at a temperature between 850-900° C.

[0045] step **406**: same as step **206**.

[0046] step **407**: same as step **207**.

[0047] step **408**: same as step **208**.

[0048] Group C is the typical example of the invention. The fabrication process is the same as for the group B except that the silicon oxide films **308**, **309** as shown in FIG. **3**, are grown by soaking the wafers in a chemical solution of 68% nitric acid at room temperature for duration of 15 minutes. The thickness of the grown silicon oxide is 1.4 nm. FIG. **5** is a flow chart showing an example of the manufacturing process according to this embodiment. The specific process condition at each process step is as follows.

[0049] step **501**: same as step **201**.

[0050] step **502**: same as step **202**.

[0051] step **503**: same as step **203**.

[0052] step **504**: same as step **204**.

[0053] step **505**: same as step **205**.

[0054] In step **506**, a silicon oxide film having a thickness of 1.4 nm is grown, by soaking the wafers in a chemical solution of 68% nitric acid at room temperature for duration of 15 minutes.

[0055] step **507**: same as step **206**.

[0056] step **508**: same as step **207**.

[0057] step **509**: same as step **208**.

[0058] In another embodiment of the invention, the fabrication process is the same as for the group B as shown in FIG. **3**, except that the silicon oxide film **308**, **309** is grown by soaking the wafers in a chemical solution of 68% nitric acid at a temperature of 120° C. for duration of 15 minutes. Solar cells resulting from this embodiment are referred to as Group D.

[0059] The solar cell properties are characterized under the condition of IEC 60904 as will be known to the skilled person. The averaged values of the solar cell parameters are shown in Table I for each of the above mentioned groups, wherein Jsc is the short circuit current, Voc is the open circuit voltage and FF is the Fill Factor.

TABLE I

The solar cell properties under the condition of IEC 60904

Group	Passivation method of the Si surface	Jsc [mA/cm^2]	Voc [mV]	FF [%]	Efficiency [%]
A	SiN	32.4	577	69.7	13.0
B	Thermal oxide/SiN	31.5	599	74.5	14.1
C	Chemical oxide grown at room temperature/SiN	31.7	620	75.6	14.8

TABLE I-continued

The solar cell properties under the condition of IEC 60904

Group	Passivation method of the Si surface	Jsc [mA/cm^2]	Voc [mV]	FF [%]	Efficiency [%]
D	Chemical oxide grown at 120° C./SiN	31.7	624	75.7	14.9

[0060] Comparing group A with groups C and D, one can see that the Voc and the power conversion efficiency are improved. Because of the thin silicon oxide intermediate layer between silicon nitride anti-reflection and semiconductor surface of groups C and D, the surface passivation of the semiconductor is strongly enhanced reducing the recombination probability of photo generated charges.

[0061] Comparing group B with groups C and D, one can see that the Voc and the power efficiency is further improved as a result of better passivation of the thin chemical oxide compared with the thermal oxide.

[0062] With adopting the invention described above, an improvement of 0.8~1.9 points in the power conversion efficiency is achieved as compared to the conventional solar cell process of n-type multi-crystalline substrate.

[0063] It will be understood that variants will occur to those skilled in the art on reading the above text. Those variants are deemed to lie within the scope of the invention as described in the appended claims.

1. Method of manufacturing a crystalline silicon solar cell, comprising:

providing a crystalline silicon substrate having a front side and a back side;

soaking the crystalline silicon substrate in a chemical solution for forming a thin silicon oxide film on at least one of said front and said back side;

forming a dielectric coating film on said thin silicon oxide film on at least one of said front and said back side, wherein said thin silicon oxide film is formed by treatment of said crystalline silicon substrate in said chemical solution at a temperature under 150° C. and wherein said thin silicon oxide film is formed with a thickness of 0.5-10 nm.

2. (canceled)

3. (canceled)

4. Method according to claim **1**, wherein said temperature is room temperature.

5. Method according to claim **1**, wherein said chemical solution comprises at least one solution selected from the group consisting of:

A. a solution containing nitric acid,

B. a solution containing hydrogen peroxide,

C. a solution containing sulphuric acid,

D. a solution containing hydrochloric acid,

E. a solution containing ozone,

F. a solution containing acetic acid,

G. a solution containing boiling water,

H. a solution containing ammonium hydride.

6. Method according to claim **1**, wherein said thin oxide film is formed by an electrochemically enhanced reaction.

7. Method according to claim **1**, wherein said dielectric coating film comprises hydrogen.