A New Method of Reduce Monocrystalline Silicon Solar Cells Surface Reflection by Silver Mirror Reaction

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Abstract

A new approach is in the pretreatment polishing silicon surface formed silver electrode through silver mirror reaction and put them into HF and hydrogen peroxide to reach electrochemical corrosion conditions according to the chemical cell reaction, formed the porous structure of silicon surface. The porous silicon solar cells in a wavelength region of 400–800 nm showed a surface reflectance below 15% milder than the conventional solutions.

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Keywords: monocrystalline silicon solar cell; light trapping structure; silver mirror reaction; electrochemical etched

1. Introduction

To improve the efficiency of by reduce monocrystalline silicon solar cell surface light reflection is essential. Some domestic and foreign researchers using porous silicon layer to reduce solar cells reflection. The reflectivity of porous silicon layer depends on its space and form. In order to get ideal porous silicon layer (PSi) the formation process should be optimization.

The traditional porous silicon layer usually through electrochemical corrosion or chemical corrosion methods to get. However, these methods hard to used in solar cells production. Although in controlled conditions electrochemical corrosion is easy to form PSi layer through adjustment layers on current or change external voltage. But the required equipment led to high investment low output. In the chemical corrosion cases, PSi layer can be get by socking the Si in contain HF and nitric acid solution. Low

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controllable and etching liquid corrosion metal electrodes lead to degradation is the main issues of solar cell in application.

We developed a new monocrystalline silicon surface treatment methods, through the chemical battery principle. Using silver mirror reactions formed positive electrode in silicon surface, silicon as negative electrode, then the silicon internally generated to loop achieve the purpose of electrochemical corrosion.

2. Experimental

2.1. The experiment equipment and materials

Using P type of single side polishing monocrystalline silicon, low doping, substrate for 6 inches 1 mm thick, wafer for <111>. Cut into 1 cm * 1 cm size with laser machine. NaOCL solution and other reagents are produced by Tianjin continental chemical reagent factory. HR4000 laser spectrometer and Quanta 200 scanning electron microscopy as performance testing instrument.

2.2. Experimental steps

Silver mirror reactions require the surface more smooth to obtain a relatively uniform silver layer, therefore, before etching the silicon surface must be completely remove the dust and organic pollution due to polishing or transportation. This experiment improve certain cleaning methods of U. Gangopadhyay, the specific cleaning steps as shown in figure 1.

In the beaker adding 2mL nitric acid silver solution, oscillation the tube, adding 2% dilute aqua ammonia, until the sediment of precipitation just has dissolved. Putting the pretreatment silicon into the beaker then drops into the beaker 1 drop of 5% sodium hydroxide solution. Adding 10% glucose solution 1 mL beaker in the tube, put the breker in the hot water heating, when the liquid surface gradually appear white light stop it.

According to Lipinskil research report, the corrosion solution is a mixture including HF (50 wt %), nitric acid (69 wt %), acetic acid (99 wt %) and pure water (2:1:1:2 volume). Putting the silicon wafer in solution, the surface silver ions dissolved in five seconds. If the sample mixed with 3% HF and 20% H2O2 (volume is 10:1), the reaction smoothly but extended the reaction time.

Putting the sample in the solution it react at 45 °C. With the increase of reaction time, the sample surface color be changed. It depends on the formation of the PSI layer, when the surface changes no longer apparent (about 1 hour or so), at this time the silver electrode in silicon surface is corroded clean, figure 2 is the energy spectrum diagram by Quanta type 200 scanning electron microscope of the sample.
2.3. The performance test and analysis

The samples surface microstructure scanning in Quanta type 200 scanning electron microscope shown in figure 3. As shown in figure, after corrosion the sample surface formed a more homogenous porous structure, it made the sun incident reflection more than one time. In those reflection process, more internal valence band electronic get light energy transition to the conduction band which improve the efficiency of solar energy surface photoelectric conversion.

Next, putting the samples in the HR4000 type laser spectrometer, illuminated in the bromine tungsten lamp, measuring the reflection strength in 10 different position of each sample then get the average strength. Importing the data in ORIGIN software, calibration the data in 632.8 nm wavelength, the PSi reflex spectrum as shown in figure 4.
From the above we can see that the monocrystalline silicon surface reflectance down to 14% or so when the sink light structure in 500 nm to 800 nm wavelength range as the method above.

3. Conclusion

This article is about silver glass reaction in silicon surface displacement out silver electrode and electrochemical corrosion methods in silicon surface make porous layer light trapping structure.

The advantage of this method is use a simple and mild process to get a minus reflection. Overcome the traditional alkali corrosion process need to add reagents, reduce the cost and improve the controllable. And can be used in \(< 111 >\) wafer of mono-crystalline silicon. Through this method, the surface natural light reflectivity controlled at 14% or so but the traditional alkali corrosion reflectivity about 20%. So this method is significant in improving monocrystalline silicon solar energy cell photoelectric conversion efficiency.

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