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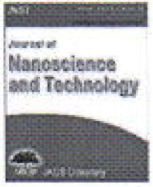

Enhancement of Solar Cell Performance Based On Porous Silicon

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ABSTRACT

Recently, nanometer size semiconductors have been a topic of great interest. Chemical etching of silicon produce P-Si layers have a strong link between the details of processing and the optical and electronic properties of the resulting structure. This paper focuses on investigation the affecting of etching time on the, etching rate, electrical properties of Psi layer and photovoltaic properties of PSi/Si solar cell. Good photovoltaic (PV) properties (the fill factor (FF) 0.77, $\Delta\eta$ 28%) was obtain with 80 seconds etching time.

1. Introduction

Silicon is the cheapest semiconductor material and its technology is the most advanced material, well-developed and least expensive compared to the technology of complex other semiconductor and it is one of the most widespread surrounding materials and one of the most common [1]. Silicon based nanocrystallines/nanoporous are some new photoelectronic and informational materials developed rapidly in recent years. For a long time, silicon has been considered unsuitable for optoelectronic applications because bulk silicon emits hardly any useful light due to its indirect band gap nature [2]. This opinion was deeply changed after the discovery of bright emission from porous silicon (PSi) and nanocrystals [3]. PSi was first discovered in 1956 by Uhlir [4] during silicon electropolishing experiments. Since then not much attention was paid to this PSi layer but from the 1990s it has been under extensive investigation after the discovery of the light emitting properties of nano Psi in the visible region by L. Canham [5], who showed room-temperature photoluminescence of an anodized p-type silicon wafer [7]. These results are well understood on the basis of the quantum-confinement model,

$$E = E_0 + \frac{3.73}{d^{1.39}} \qquad (1)$$

where the emission energy is shifted towards blue light with respect to the band gap of bulk silicon E0 = 1:17 eV and correlates with the nanocrystallite size d [7]. PSi has great scientific and technological interest because of its ample range of applications. Such material is very promising for application to silicon solar cells, due to its combination of light trapping, antireflection properties and light conversion ability [8].

PSi has emerged as an attractive material in the field of electronics and optoelectronics due to its broad band gap, wide optical transmission range (700–1000 nm), wide absorption spectrum, surface roughening, and lower effective refractive index, which can reduce the reflection losses of sunlight radiation, are the primary factors that enhance PSi compared with c-Si [9,10].

The amount of light reflection from the surface is the main obstacle in efficient solar cell performance because reflection is related to the refractive index of the material. For instance, the silicon refractive index is 3.5 which prevents an electron-hole pair from being generated and could reduce the efficiency of photovoltaic converters. Antireflection coatings (ARC) are able to reduce surface reflection, increase conversion efficiency, extend the life of converters and improve the electro physical and characterization of photovoltaic converters. It is attractive in solar cell applications because of its efficient ARC and other properties such as band gap broadening, wide absorption spectrum, and optical transmission range (700–1000 nm) [11]. In continuous to or work [12-17], herein we try to improving the fatigue life of brass alloy. Comparing with the fatigue life of the sample untreated by LSP, fatigue life is increased by 64% for brass at lower stress level. The fatigue crack initiation and growth of the sample treated by LSP could be restrained more effectively.

2. Experimental Methods

The preparation of the samples involved two steps: first, the preparation of the silicon solar cell starting with highly doped p-type (100) oriented silicon substrate with a resistivity of 0.05–0.1 Ω.cm, p-n junction made by deposed antimony (Sb) thin films on mirror like side of the wafer using thermal evaporation system (Balzer BAE 370) then the sample annealed in vacuum oven (memmert) for (400 °C, 10^{-3} bar), second, preparing PSi layer by cutting the wafer into small pieces, These pieces were rinsed with ethanol to remove dirt followed by etching in dilute (10%) hydro fluoric acid (HF) for a period of about (10 min) to remove the native oxide layer. The samples rinsed with ethanol and left in environment for a few minutes to dry and after that stored in a plastic container filled with ethanol to prevent the formation of oxide layer on the prepared sample. The chemical etching process has been carried out at room temperature.

The chemically etched area for all samples has been of (1.5 cm^2). The PSi was etched in (40% HNO_3, / 40% HF) mixture (1/1) for 20, 40, 60 and 80 s etching time, the samples are ultrasonic treatment during etching with 30 KHz frequency this treatment improve the porous silicon structure [12, 13].

Ohmic contacts of Al thick films were evaporated on both sides of the wafer using thermal evaporation system (Balzer BAE 370) in order to study the solar cell characters. The low resistivity of these wafers enables a good contact between the wafer and its back-side metallic connection (aluminum disk).

Thickness and porosity of the samples were calculated by the gravimetric method. The samples are weighted before etching (m_1), just after etching (m_2), and after dissolution of the PSi layer in a molar KOH aqueous solution (m_3). The porosity and thickness are given by the following equations, respectively,

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