Available online at www.sciencedirect.com

SciVerse ScienceDirect

Energy Procedia 33 (2013) 118 – 128

Energy Procedia

PV Asia Pacific Conference 2012

Optimisation of the Back Surface Reflector for Textured Polycrystalline Si Thin Film Solar Cells

Hongtao Cui*, Patrick R. Campbell, Martin A. Green

School of Photovoltaic and Renewable Energy Engineering, The University of New South Wales, Sydney NSW 2052, Australia

Abstract

The back surface reflector of a solar cell not only enhances back reflection, but also may contribute to further randomising light. In this paper, three different types of back surface reflectors (dielectric/metal bi-layer, pigmented diffuse reflector and Ag nanoparticles) are investigated and compared with one another to determine the optimal for polycrystalline Si (poly-Si) thin film solar cells grown on textured glass superstrates. The optimal dielectric layer material and thickness of an interposed dielectric layer between Si and metal contact is optimised via WVASE simulation for ~2 μm random textured poly-Si thin film solar cells on glass. Experimentally, the Si thin films are deposited on Aluminium Induced Textured (AIT) glass and those with optical absorption close to Lambertian limited absorption are selected for investigation. The experiment confirms the simulation results and finds the best back reflector configuration— 500 nm MgF_2+Ag. Theoretically Ag nanoparticles on the rear surface of a cell should induce surface plasmon effects, scattering light obliquely into the Si film. However, this work indicates that Ag nanoparticles degrade J_{sc} of textured poly-Si thin film solar cells. The reason why Ag nanoparticles do not work on textured poly-Si thin film solar cells needs further investigation.

Selection and peer-review under responsibility of Solar Energy Research Institute of Singapore (SERIS) – National University of Singapore (NUS). The PV Asia Pacific Conference 2012 was jointly organised by SERIS and the Asian Photovoltaic Industry Association (APVIA)

Keywords: Back surface reflector; polycrystalline silicon; textured thin film; solar cells

* Corresponding author. Tel.: +61-430006325
E-mail address: h.cui@unsw.edu.au

Selection and peer-review under responsibility of Solar Energy Research Institute of Singapore (SERIS) – National University of Singapore (NUS). The PV Asia Pacific Conference 2012 was jointly organised by SERIS and the Asian Photovoltaic Industry Association (APVIA)
doi:10.1016/j.egypro.2013.05.048

1. Introduction

Poly-Si thin-film solar cell on glass technology, inheriting the advantages of both wafer Si solar cell technology which dominates the market and the low cost potential of thin-films is promising for future solar applications [1]. A schematic of the poly-Si thin-film solar cell on glass in the superstrate structure is shown in Fig. 1.

Light management of this type of solar cells involves three interfaces functioning to either couple more light into a Si film, or enhance light trapping inside the Si film. The air/glass interface structured to reduce the primary and secondary light reflection, therefore couple more light into the Si film. The glass/Si interface is structured via glass texturing to enhance light trapping inside the Si film. The Si/ back reflector interface designed to maximise back reflection and to potentially enhance light trapping as well. The first two effects have been investigated intensively over past years [2-5].

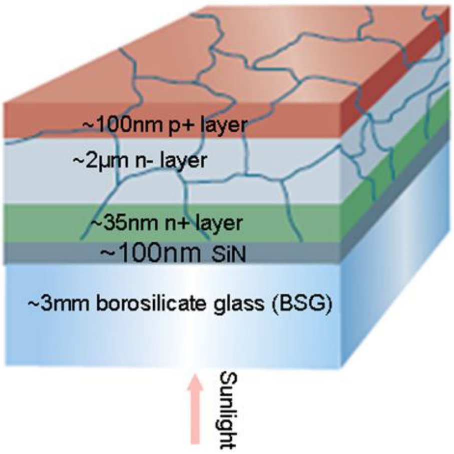

Fig. 1. The schematic structure of poly-Si thin-film solar cell on glass superstrate.

In this paper, three types of back reflectors are investigated and compared with one another to determine the optimal: (1) interposing a dielectric layer between Si and metal contact; (2) pigmented diffuse reflector (i.e. white paint) and (3) Ag nanoparticles. The three reflectors are introduced briefly in the following paragraph.

A sensible reflector design requires an intermediate dielectric layer (or rear encapsulant) so that total internal reflection can be relied on for light travelling at oblique angle [6]. For a wafer based solar cell, interposing a SiO_x layer between Si and Al contact enhances back reflection [7] and also improves back surface passivation [8], and is therefore adopted in high efficiency cell design [9]. This scheme was also applied on poly-Si thin film solar cell on glass and led to a significant short circuit current density enhancement [10]. To determine the optimal back reflector configuration, a WVASE simulation is used to identify the optimal dielectric layer material and thickness. Additionally, white paint is also used for comparison with the optimal configuration above, since it is widely available, cost effective and reflects light diffusely [11, 12]. However, even assuming a Lambertian distribution of light in the paint, refraction at the Si/paint interface results in a focused Lambertian distribution [11]. Paint is proved not as effective