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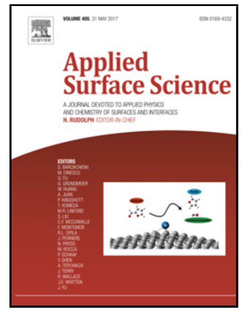

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Author: Ruy S. Bonilla Christian Reichel Martin Hermle Phillip Hamer Peter R. Wilshaw

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Long term stability of c-Si surface passivation using corona charged SiO_2

Ruy S Bonilla[1*], Christian Reichel[2], Martin Hermle[2], Phillip Hamer[1,3] and Peter R Wilshaw[1]

1- Department of Materials, University of Oxford, Parks Rd, Oxford, OX1 3PH, United Kingdom

2- Fraunhofer Institute for Solar Energy Systems ISE, Heidenhofstr. 2, Freiburg, 79110, Germany

3- School of Photovoltaics and Renewable Energy Engineering, University of New South Wales, Sydney, N.S.W 2052, Australia

Abstract- Recombination at the semiconductor surface continues to be a major limit to optoelectronic device performance, in particular for solar cells. Passivation films reduce surface recombination by a combination of chemical and electric field effect components. Dielectric films used for this purpose, however, must also accomplish optical functions at the cell surface. In this paper, corona charge is seen as a potential method to enhance the passivation properties of a dielectric film while maintaining its optical characteristics. It is observed that corona charge can produce extreme reductions in surface recombination via field effect, in the best case leading to lifetimes exceeding 5 ms at an injection of 10^{15} cm^{-3}. For a 200 μm n-type 1 Ωcm c-Si wafer, this equates to surface recombination velocities below 0.65 cm/s and J_{0e} values of 0.92 fA/cm^2. The average improvement in passivation after corona charging gave lifetimes of 1-3 ms. This was stabilised for a period of 3 years by chemically treating the films to prevent water absorption. Surface recombination was kept below 7 cm/s, and $J_{0e} <$ 16.28 fA/cm^2 for 3 years, with a decay time constant of 8.7 years. Simulations of back-contacted n-type cells show that front surface recombination represents less than 2% of the total internally generated power in the cell (the loss in power output) when the passivation is kept better than 16 fA/cm^2, and as high as 10% if front recombination is worse than 100 fA/cm^2.

Keywords- surface passivation, silicon solar cells, dielectric thin films, corona discharge.

1 Introduction

Crystalline silicon (c-Si) continues to be the leading material for solar cell production. In highly efficient mono c-Si cells, surface recombination of charge carriers is a limiting factor in achieving optimal performance. Reducing surface recombination, also known as surface passivation, is therefore of utmost importance. Furthermore, as cell geometries in which all contacts are on the cell's backside become increasingly popular, front surface passivation becomes even more crucial. The surface in a semiconductor is an abrupt crystal discontinuity. At a bare silicon surface, many atoms may be partially bonded and hence possess dangling bonds that create intermediate band-gap energy levels, also known as surface energy traps or surface states, which promote recombination [1]. In general usage, the term 'surface' refers to a solid-air interface. However, in practical solar cells, bare semiconductor surfaces are not present and recombination actually takes

[*] Corresponding author: sebastian.bonilla@materials.ox.ac.uk