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ORIGINAL PAPER

Impact of interface microstructure on adhesion force between silver paste and silicon solar cells' emitter

Hong Yang · Chuanke Chen · He Wang · Dingyue Cao · Xiandao Lei

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Abstract The adhesion strength between silver paste and silicon solar cell's emitter is a primary source of long-term degradation in solar modules. In this study, the interface microstructure between screen-printed silver thick-film and silicon solar cells' emitter was studied. Three kinds of commercial silver pastes were printed on silicon solar cells' emitter to form different Ag–Si contact structures. The interface microstructure between silver paste and emitter was observed by SEM, while the compositions of Ag thick-film were analyzed by EDX. The deductions we got from SEM and EDX were verified by the pull test for the first time. The results presented in this study give some suggestions to the development of silver paste and crystalline silicon solar cells' fire-through.

Keywords Solar cells · Adhesion strength · Silver paste · Interface microstructure

Introduction

At present, the screen-printed silver pastes are widely used for the front side metallization of crystalline Si solar cells. The interface microstructure between the screen-printed silver thick-film and silicon solar cells' emitter from different silver paste producers is different, so it leads to different mechanical properties and electrical performance between silicon substrate and silver front contacts. Some silver pastes have good electrical performance, but they have weak adhesion force between the silver thick-film and silicon solar cells' emitter. Although much work that the silver pastes affect the conductive property of cells has been studied by many scientists (Zhang et al. 2008; Pysch and Mette 2009; Green 2011; Cabrera et al. 2011), few people investigated the adhesion force between the screen-printed silver thick-film and silicon solar cells' emitter by an interface microstructure analysis. In this paper, the interface microstructure of Ag–Si contact was studied by Scanning Electron Microscopy (SEM), and the components of Ag thick-film conductors were studied by Energy Dispersive X-ray Spectrometer (EDX). The sintered interface of the silver paste marked by paste C has a denser microstructure, fewer and smaller size pores in silver thick-film and Ag–Si interface than others. This interface force between the screen-printed silver thick-film and silicon solar cells' emitter is larger than others, which proved by the macroscopic pull test. The results presented in this study give some suggestions to the development of silver paste and crystalline silicon solar cells' fire-through.

Experimental

In this experiment, the 125 mm × 125 mm pseudo-square P-type Cz-Si wafers with 1–2 Ω cm base resistance were applied for this study. After the saw damage, these wafers were chemically cleaned and texturized, and then followed by $POCl_3$ diffusion to form the n+ (60–65 Ω/square) emitters. After edge-isolated and phosphorus glass removal, the SiNx:H antireflection coating was deposited by PECVD. Lastly, the screen-printed silver thick film back contact, screen-printed aluminum paste back surface field, and silver-thick film front-contact were prepared and

H. Yang · C. Chen · H. Wang (✉) · D. Cao · X. Lei
Institute of Solar Energy, MOE Key Laboratory for Nonequilibrium Synthesis and Modulation of Condensed Matter, Xi'an Jiaotong University, Xi'an 710049, People's Republic of China
e-mail: hw69cn@126.com

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