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Effect of Si Content in AlSi Local Rear Contacts of n-PERT Solar Cells on the Al-p+ Junction Formation

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ABSTRACT

This works investigates the effect of Si content on the Al-p+ junction formation on the AlSi local rear contacts for the n-PERT Si solar cells. For this, the Al paste was modified by adding Si powder with content up to 6%wt. After that, the prepared Al-Si pastes were screen- printed on the n-type Si wafers. The Al-Si pastes were then fired in RTP furnace at a set peak temperature of 783 °C under N2 atmosphere to form the AlSi local rear contacts. The Al-Si pastes were then examined using the optical microscope, Scanning Electronic Microscopy (SEM) and the X-ray diffraction. The results showed that the added Si powder affected the properties of the Al-p+ junction as well as the Al-Si eutectic layer between the Al-p+ junction and the AlSi local rear contacts.

Keywords: AlSi local rear contacts, Si content, screen printing, n-PERT Si Solar cell.

1. Introduction

Passivated Emitter Rear Totally Diffused (PERT) solar cell has attracted an increasing attention as a promising candidate in photovoltaics (PV) due of its outstanding properties [1]. One of the way to improve the performance of the n-PERT solar cells is to improve the properties of Al-p+ junction at the Al local rear contacts. This Al- p+ junction acts as an electric shielding to repel minority charge carriers, which prevents the recombination at the rear side of the Solar cells [2]. In the present work, we have tried to improve the properties of the Al- p+ rear junction on the n-PERT Si solar cells by the Si powder to the Al paste. The structural properties of the Al- p+ rear junction were investigated by optical microscope, SEM and XRD analysis in order to investigate the effect of the Si content added on the Al paste on the properties of the Al-p+ rear junction.

2. Experimental

In the present work, the n-type, (100)-oriented Cz–Si wafers were used as substrate. The wafers were prepared according to the standard procedure reported elsewhere [3,4]. Al-Si pastes were prepared by mixing the Al based paste with the Si powder having a particle size of 8-16 µm. During the mixing process, a droplets of a specific diluent have been added to facilitate to maintain the viscosity of the paste. The prepared Al-Si pastes were screen printed on the Si substrate using EKRA printer. The screen printed pastes were dried at 250 °C in for 5 min and then fired in RTP AllWin21 Accu Thermo AW610 furnace at a set peak temperature of 783 °C under N2 atmosphere. The surface state of the Al-Si paste was analyzed using Axio Scope Al light Optical Microscope. The cross-sectional SEM micrographs of the Al-Si contacts were characterized using SM-7610Fplus SEM. The phase composition on the Al-Si paste was investigated X Pert PRO, PANalytical diffractometer.

3. Results and Discussion

Figure 1 shows the optical micrographs of the surface states of the screen-printed Al-Si pastes. As shown, porosities is observed on the surface of the pastes. This is due to the evaporation of existing solvents in the aluminum paste during the annealing process. However, the number of porosities is higher at the surface of the Al-Si paste compared to the Al paste. This can be attributed to the added diluent during mixing the Al paste with the Si powder.

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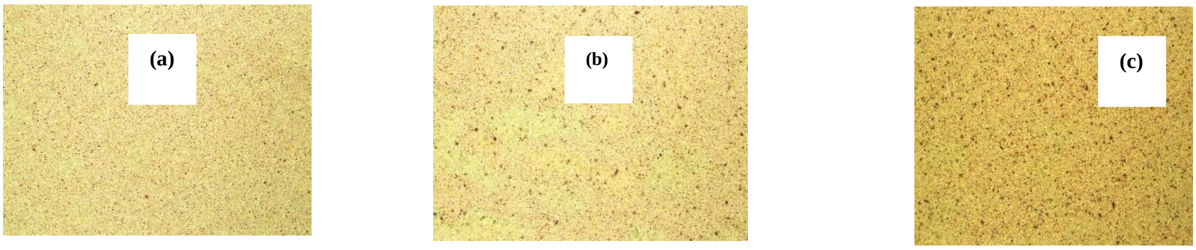

Figure 1: optical micrographs of the surface state of the different pastes: a) Al pure, b) Al-3%Si, c) Al-6%Si.

Figure 2 presents the cross-sectional SEM micrographs of the Al-Si contacts for the different Si contents. For the differ(a) contents, it is noted the formation of the AlSi eutectic phase at the interface between the AlSi contacts a... ...e Si substrate due to the diffusion of Aluminum towards the Si substrate [2]. It is also noted a formation of the Al-p+ junction under the AlSI eutectic layer. However, the higher thickness of the AlSi eutectic layer is obtained for Al-3%Si paste, resulting in a higher thickness of the Al-p+ junction. The higher thickness of the Al-p+ junction obtained for Al-3%Si can be explained by the fact that 3%Si content is the appropriate Si continent to add in the Al paste, which limits the Si out-diffusion toward the Al paste, leading to thicker Al-p+ junction and thereby the better Si solar cell performance.

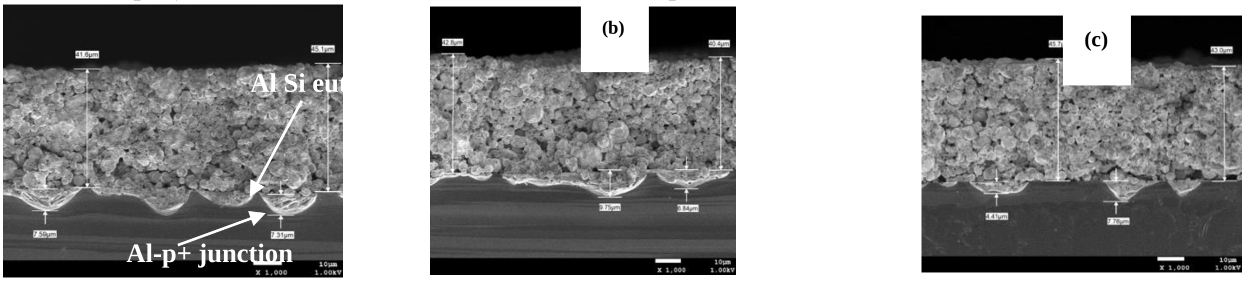

Figure 2: Cross-sectional SEM micrographs of the Al-Si contacts for the different pastes: a) Al pure, b) Al-3%Si, c) Al-6%Si.

Figure 3 presents the XRD patterns of the Al-Si contacts for the different Si contents. All the XRD patterns exhibit the Al and the Si peaks. However, the number of the Si peaks is higher for the Al-3%Si paste compared to the other pastes. It is also observed peaks of SiO2 in the pastes containing Si powder compared to the Al paste.

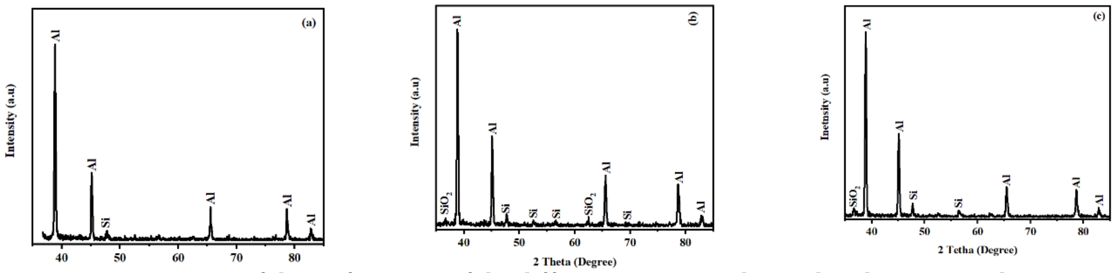

Figure 3: XRD patterns of the surface state of the different pastes: a) Al pure, b) Al-3%Si, c) Al-6%Si.

4. Conclusion

The properties of the Al-p+ rear junction in the n-PERT Si solar cells could be improved by adding the appropriate Si content to the Al paste.

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