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6th Workshop on Metallization and Interconnection for Crystalline Silicon Solar Cells, 2016

Summary of the 6th Workshop on Metallization and Interconnection for Crystalline Silicon Solar Cells

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Abstract

The 6th Metallization Workshop took place in Constance, Germany on 2 and 3 May 2016. At the workshop the latest progress in the understanding and application of metallization and interconnection was presented. Screen printed metallization continues to dominate. Material and application technologies are constantly further improved, with sub-40 µm fingers with high cell performance and low Ag consumption demonstrated. Cu plating technology is further perfected in anticipation of large scale industrial implementation, with improvements on adhesion and long term reliability. In interconnection, alternatives to the traditional ribbon soldering technology are proposed. Among them, the multi-wires interconnection schemes are shown to have a dramatic impact on metallization design and technology.

Peer-review under responsibility of the organizing committee of the Metallization Workshop 2016

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1. Introduction

The Metallization Workshop series started in 2008. At the time, the EU-funded Integrated Project Crystal Clear was running, which included a sub-project on dissemination of knowledge and integration of the European PV R&D community. Recognizing the special technological and scientific importance of solar cell metallization, the project coordinator approved and sponsored an open workshop devoted to the topic. The purpose was to offer a forum for

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experts in solar cell metallization and foster interaction between them. Although this was meant as a one-time event, the success of the first event led us, the Metallization Workshop organizers, to organize a second workshop, one and a half year later, without any public funding. Other editions followed and were also successful, and by now, the Metallization Workshop series is established and recognized as the prime specialized event in the field, attracting a steady number of experts from R&D institutes, universities and industry and made largely possible by private sponsors.

The 6th Metallization Workshop was held in Konstanz, Germany on 2-3 May 2016. Compared to previous editions, the scope of the Workshop was expanded to cover both cell metallization and interconnection. There were several reasons for this. First there is a clear trend towards optimizing cell metallization and interconnection simultaneously in order to reach best performance and lowest cost at module level. Moreover, there is a clear interaction between cell metallization and interconnection, and today neither can be designed nor developed independently. Although the topic of interconnection had been touched upon in several talks at the previous workshops, it was explicitly included in the 6th Workshop to give it the right attention and time. The Workshop's full name has accordingly been modified to 'Workshop on Metallization and Interconnection for Crystalline Silicon Solar Cells', while the short name remains 'Metallization Workshop'.

The Workshop was this time again a success. Around 145 experts, from 21 different countries around the world, attended, and the program consisted of 31 selected presentations. The slides and posters are freely accessible at the Workshop website: www.metallizationworkshop.info. This paper attempts to give an overview of the Workshop and at the same time to provide a snapshot of the present status and understanding of the science and technology of solar cell metallization and interconnection.

2. Screen printed metallization

Screen printed metallization (Ag for front contacts, Al for most of the rear surface, and Ag or AgAl for the solderable contacts at the rear) is by far the most dominant technology for crystalline Si solar cells and receives accordingly a lot of attention

2.1. Formation of Ag screen printed contacts

The general morphology of screenprinted contacts, featuring Ag crystallites and/or Ag nanocolloids in intimate contact with the silicon surface and an intermediate glass layer has been revealed by many studies in the past ([1-3] and many others) but the formation mechanism is not so well understood. At the Workshop, it was proposed that the reactions occurring during Ag contact firing are electrochemical in nature, where the molten glass acts as a liquid electrolyte containing mobile Ag^{+} and O^{2-} ions [4]. Experimental evidence for this mechanism was given, involving electroluminescence imaging, contact resistance measurements and direct measurement of the potential difference between contact and silicon during firing.

2.2. Improvement of Ag screen printing pastes

Over the last twenty years or so, there has been a constant improvement of Ag screen printing pastes. Structures that were deemed impossible at one time, such as contacting a homogeneous emitter with sheet resistance exceeding 60 ohm/sq., not only became possible but also routinely practiced in the industry. This was achieved through constant R&D and fast commercialization efforts by paste manufacturers. Their astonishing and repeated breakthroughs have been a large contributor to solar cells constant efficiency increase over the years. At the Workshop it was shown that these efforts are continuing, with emphasis on understanding and lowering recombination losses underneath Ag contacts [5, 6] and achieving narrow and tall contacts with paste formulation that enable an industrially feasible process [7].