

- 1 Industrial type inline tool for copper plating at Fraunhofer ISE. ©Achim Käflein
- 2 156 x 156 mm² solar cell after copper plating process.
- 3 Solar cell contact with plated nickel (1), copper (2) and tin (3) with 20 µm width.

PLATED COPPER METALLIZATION FOR SI-PV CELLS AND MODULES

Fraunhofer Institute for Solar Energy Systems ISE

Heidenhofstr. 2
79110 Freiburg, Germany
Phone +49 761 4588-0
Fax +49 761 4588-9000

Silicon Photovoltaics – Metallization and Patterning

Plating Process Technologies

Dr Jonas Bartsch
Phone +49 761 4588-5737

Laser Process Technologies

Dr Jan Nekarda
Phone +49 761 4588-5563

sipv.contact@ise.fraunhofer.de
www.ise.fraunhofer.de

Solar cell metallization is a crucial point of optimization for silicon solar cells both technologically and from a cost point of view. The introduction of optimized emitters with low surface doping concentrations enables solar cell efficiency improvements in advanced silicon solar cell concepts. Silver material for metallization may become critical in the future with respect to high material costs, cost fluctuations and large scale availability.

A plated metallization overcomes these challenges. In combination with advanced laser processes, very narrow contact lines consisting of nickel, copper and tin or silver can be applied to many different cell structures.

Plated metallization schemes are available for many different standard and next generation solar cell concepts.

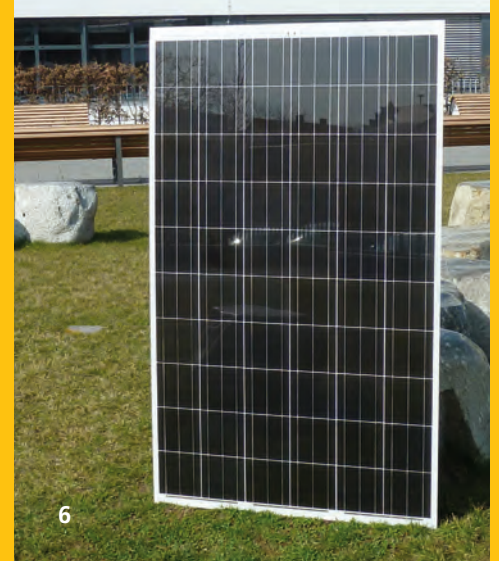
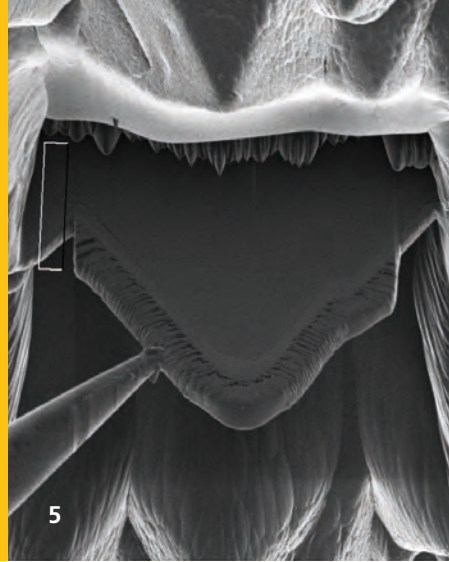
Advantages of Plating

- low contact resistivity to both p-type and n-type Si, highly conductive bulk metals
- low cost materials (Ni/Cu)
- narrow, homogeneous fingers with widths down to 20 µm
- cost-effective wet chemical application method

Cell Concepts Feasible for Plating

- p-type BSF solar cells
- p-type PERC solar cells
- n-type PERT solar cells
- bifacial solar cells
- heterojunction solar cells
- back-contact solar cells

Since each of these solar cell concepts has individual demands on the metallization process, we devise customized plating processes to meet the specific requirements of our customers.



Fraunhofer ISE has been working in plated solar cell metallization approaches for more than 20 years. We offer in-depth counseling for the application of plating and associated processes for all of the above mentioned cases.

Our Offer

- support with sample design optimization (ARC, texture)
- optimal ARC laser patterning
- plating stack and grid design
- thermal treatment
- electrical characterization of cells from macro- to nano-scale
- soldering and peel strength optimization
- module construction and IEC testing
- evaluation of copper diffusion stability on cell level

All evaluations are realized using industrial type processing tools. Additionally, Fraunhofer ISE offers the largest selection of characterization tools available for photovoltaics (including several of our own developments).

Our network comprises all major suppliers of process solutions (i. e. industrial plating machines, chemical solutions, analysis tools).

Cooperation

A first demonstration is typically designed as follows:

- customer provides own pre-processed solar cell substrates without metallization
- metallization process as agreed upon with Fraunhofer ISE (e. g.: rear printing, laser ablation, firing, plating)
- solar cell and contact characterization at Fraunhofer ISE: IV-testing, further electrical measurements (if required), microscopy, solder / peel testing
- module construction (small / standard size) can be performed at Fraunhofer ISE
- electronic summary report for customer

Based on your requirements, we will create an offer for your individual needs.

Reference Customers

- Tetrasun / First Solar
- Hyundai Heavy Industries
- REC Solar
- Hanwha Q-Cells
- Solar World

4 Copper plated IBC electrode on 125 x 125 mm² wafer.

5 Lamella lift-out for microstructure study of solar cell metallization interface.

6 60 cell module with plated solar cell contacts fabricated at Fraunhofer ISE.