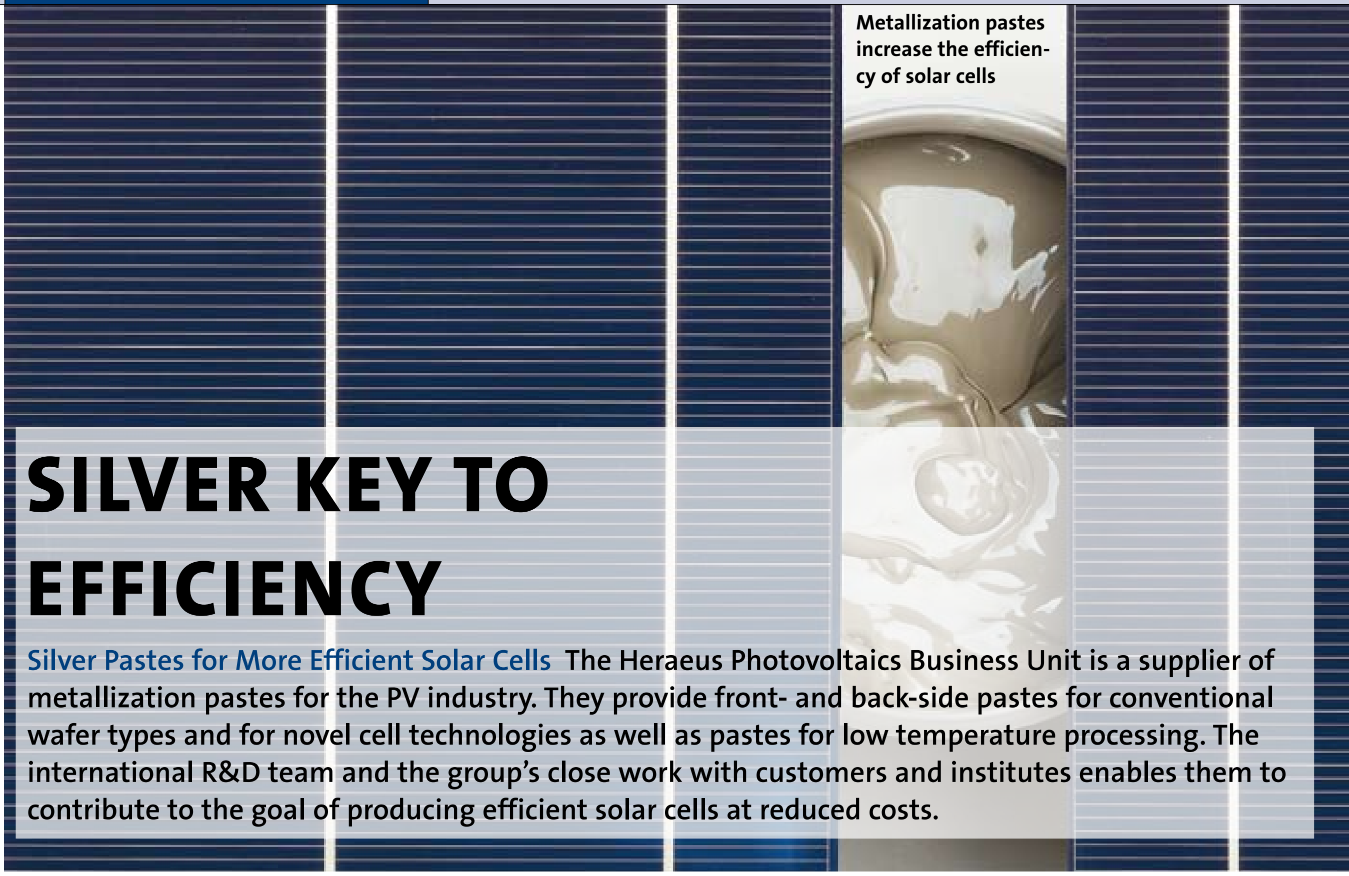


Metallization pastes increase the efficiency of solar cells

SILVER KEY TO EFFICIENCY

Silver Pastes for More Efficient Solar Cells **The Heraeus Photovoltaics Business Unit is a supplier of metallization pastes for the PV industry. They provide front- and back-side pastes for conventional wafer types and for novel cell technologies as well as pastes for low temperature processing. The international R&D team and the group's close work with customers and institutes enables them to contribute to the goal of producing efficient solar cells at reduced costs.**

Pictures: Heraeus

Key cost cutting factors are higher efficiencies, lower paste consumption, and reduced silver content. Products such as silver metallization pastes can improve the performance of solar cells. "We are constantly developing formulations to advance the metallization of solar cells and thus increase their performance. The key customer demand is to reduce the cost per watt of solar power by employing cost-saving materials", commented Carsten Mohr, manager of the Photovoltaics Business Unit Europe.

More Efficient Solar Cells

Silver metallization pastes are strategically important materials for the manufacture of solar cells. The performance of the pastes determines the efficiency with which solar cells and modules will convert sunlight into usable energy. An efficient solar cell requires a well designed and formulated metallization paste that will conduct the greatest possible proportion of the power generated from the core of the cell to the electrical grid. In the value chain, metallization pastes are needed in the process of manufacturing a solar cell from a silicon wafer. The paste is typically applied to the wafer by screen printing. On the front side of a conventional cell, the paste is visible as a grid of very fine lines, which are highly conductive. On the back side, metallization paste is necessary to create the back-side contacts, the so-called busbars, or pads. The lines conduct electric power from the inside to the outside of the cell. Finally, a set of cells are soldered to one another and assembled to a module.

Autor

Carsten Mohr, Manager of the Heraeus Photovoltaics Business Unit Europe

Silver for Metallization

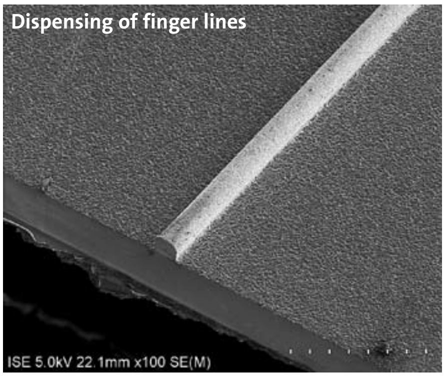
Silver, as a precious metal, is a cost-intensive material with a volatile price. However, it is the most conductive element available and silver pastes have long-term stability, meaning that their conductivity does not significantly diminish in the course of the lifetime of the cell. Also, the precious metall is highly corrosion-resistant, a necessary feature facing the economic life-time of at least 20 years of solar modules. Finally, silver pastes have good solderability, important in the process of assembling several cells to a module.

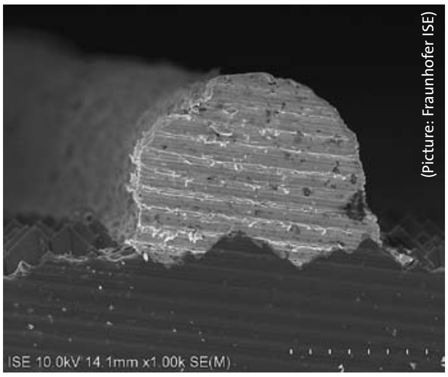
With the demand for silver paste increasing and the price of silver rising significantly during the past year, new solutions are necessary in order to reduce the customer cost. New generations of pastes are required to provide increased efficiency while reducing paste consumption and silver content. Those are critical features to reduce the customer costs. There are basically two approaches to achieve this goal. One option is to reduce the amount of paste used per cell, while at a minimum, maintaining the performance of the cell. The other option is to reduce the silver content of paste without sacrificing performance. The company constantly develops new paste formulations with the objective of optimizing the above mentioned key factors.

Novel Solar Cell Design Concepts

Novel cell design concepts will always thrive to reduce the disadvantages of conventional cell technologies. One example is the MWT technology, which aims at lowering shading of the front-side contacts. The busbars typically found on the front-side of conventional solar cells are shifted to the back-side of the cell, thereby reducing front-side shading which results in more light to actually hitting the cell. The additional benefit is that less paste is required. The producer offers low shunting pastes specially formulated for this design concept. It can be used as via paste to connect front- and back-side of the MWT-cell and also as paste for printing the solder pads. The company has introduced these new low shunting via pastes to the market in the first quarter of 2012.

N-Type solar cells have proved to be an alternative to conventional solar cells. Higher cell efficiencies can be achieved with a higher tolerance against





(Picture: Fraunhofer ISE)

FACTS FOR DECISION MAKERS

Following Customer Needs

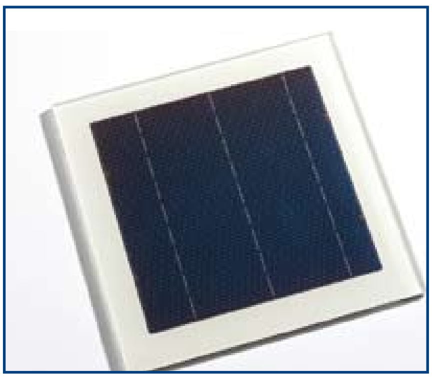
Current customer needs can easily be summarized under two headings: high cell efficiencies and low production costs. The following fields of technology offer optimization potential:

- Novel solar cell design concepts
- Optimized screen printing techniques
- New printing techniques
- New material systems

metal impurities. The supplier offers pastes for P^+ as well as for N^+ surfaces of n-Type monocrystalline solar cells.

In Double Printing, an additional layer of paste is printed on the first layer. The objective of this method is to print tall, narrower lines, thereby increasing the aspect ratio, resulting in lower shading and higher efficiencies. The company provides their customers with a front-side silver conductor for silicon solar cells that is specially formulated as a second layer for front-side finger lines and busbars for this technology. For the first layer, conventional front-side pastes are available.

For Dual Printing, front-side pastes are applied in two steps. In the first step, the finger lines are printed using a conventional front-side paste. In the second step, the busbars are printed using a low activity paste. As opposed to conventional pastes, low activity paste does not penetrate the passivation layer in order to get connected to the emitter. The advantage is that a greater part of the surface layer stays intact and there are fewer defects to the emitter, which results in higher efficiencies. The paste features a lower silver content than conventional pastes because it does not need the same conductivity as a paste used for printing finger gridlines. In 2012, new low activity pastes have been introduced in addition to conventional front-side pastes..



Picture: Fraunhofer ISE

The MWT-Perc technology reduces front-side shading.

Low activity pastes can also be used as tabbing paste for backside passivated solar cells. Backside passivated solar cells feature a passivation layer on the backside, which is not the case for conventional solar cells. Insulating the rearside helps gaining higher efficiencies. Structuring of the passivation layer before the firing process or laser fired contacts (LFC) allow local connection of the bulk material whereas the major surface of the passivation layer stays intact. The supplier's low activity pastes with their soft formulation and good adhesion properties (the paste does not need to be fired through the passivation layer, hence "soft") are ideal for printing the solder pads on the backside
As compared to crystalline solar cell concepts, Thin Film technologies offer possibilities for lowering production costs. In 2011 the company has introduced a new series of pastes for low temperature processing of thin film cell technologies such as organic solar cells, dye-sensitized solar cells and temperature sensitive applications like solar cells printed on plastic carriers. In the same way, the paste can be used for Perl, Hit and other crystalline cell technologies.

Screen Printing Techniques

A number of approaches, both in screen and stencil printing, have led to a reduction in paste usage on solar cells. Main drivers are narrower and more uniform finger-lines, better homogeneity and better paste transfer.

The conductivity of a finger-line is determined and limited by the lowest point in its elevation profile. By reducing the finger-line height variability, manufacturers are able to use the paste more efficiently. As far as the uniformity of the lines is concerned, stencil-printing techniques lead to improved results compared to screen-printed lines.

The combination of screen and stencil printing is particularly successful, both in research projects and industrial applications. Let's take Dual Print for example. For some cell manufacturers, in the first step of the process, the busbars are screen-printed on the wafer with slots being left empty for the finger lines. In a second step, the fingers are printed using a stencil. Other cell manufacturers will reverse the steps of this process.

The joint effort of screen and stencil suppliers with the company's ability to customize pastes improves these technologies and processes. This collaborative effort continues to lower the paste usage per cell and obtain higher efficiency yields for customers.

Printing Techniques

Screen and stencil printing are two methods used for the contact printing of solar wafers. Beyond that, there are new advanced non-contact printing methods such as dispensing and laser transfer printing. In joint projects with partners, the suppier has started the development of pastes and inks for non-contact printing technologies. Non-contact printing will eliminate the cost of screens and opens new possibilities for fine-line printing.

Since customized pastes are an important enabler for new printing techniques, the Heraeus R&D team constantly researches, both in internal projects and together with partners, possibilities to lower Ag content of front-side and back-side metallization pastes to minimize customer costs. ■

CONTACT

www.pvsilverpaste.com