Technical Facts and Details

With the stringer equipment in the Module-TEC production laboratory, Fraunhofer ISE is able to offer customers highly flexible development of soldering processes as well as extensive testing of innovative lead-free solder alloys:

- solder interconnection of PERC, SHJ, TOPCon and tandem solar cells
- flat ribbons or round wires coated with low-temperature lead-free solder alloys
- string production for wafer formats between 140 mm (M0) and 210 mm (G12) edge length for various amounts of busbars and multiwire interconnections
- analysis of the soldering homogeneity for large wafers
- stress-reduced and damage-free low-temperature soldering in the temperature range between 150 °C (low-temperature alloys) and 260 °C (Sn60Pb40 alloy)
- lead-free soldering by industrial processes with max. speed of 1.3 s per wafer
- detailed testing of soldering fluxes for desired process temperatures
- evaluation of lead-free solder alloys on string and module level: material testing, joint characterization, long-term stability, module characterization
- characterization of solder alloys, solder joints on solar cells and in solar modules
- stringer assessment and identification of actions for process optimization

Further informations

Module-TEC

Lead-free interconnection

Infrared soldering unit of the stringer in the Module-TEC of Fraunhofer ISE for low-temperature soldering with lead-free solder alloys.

Cover photo: Solar cell string on the stringer transportation belt in the Module-TEC production laboratory of Fraunhofer ISE.

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Lead-Free Soldering

Low-Temperature Interconnection Technology for Solar Cells

R&D for the Energy Transition

Low-Temperature Interconnection Technology

Lead-free soldering allows for an RoHS-compliant interconnection process on conventional stringer equipment. Additionally the temperature can be reduced to < 220 °C if desired. Using lead-free solder alloys and appropriate flux, creating mechanically stable solder joints on the metallization of temperature-sensitive solar cells can be achieved.

Our Service Offer to Module Manufacturers, Material Suppliers

Selection of suitable materials for solar cell interconnection

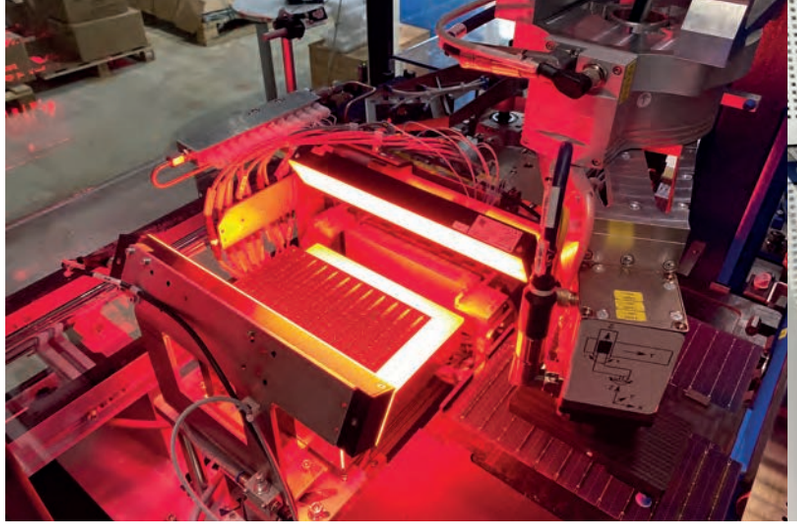
- cell-compatible lead-free solder alloys
- suitable flux with adapted activation
- alternative lead-free interconnection techniques

Process development for low-temperature soldering on industrial stringers

- soldering profiles for SHJ or tandems, as well as PERC and TOPCon
- interconnection of various busbar and pad designs using flat ribbons or round wires; interconnection of busbar-less solar cells by SWCT®
- homogeneous quality of solder joints for large wafer sizes up to 210 mm edge length

Extensive characterization measurements on solder joints

- optical and surface characteristics
- mechanical properties
- electrical characterization
- microstructural analysis
- long-term stability behavior



Solar cells on the breakage control unit of the stringer in the Module-TEC production laboratory of Fraunhofer ISE (G12 half cells)

Solar cell strings (front side and rear side) on the stringer transportation belt after lead-free soldering

Elimination of Lead in Solder Joints

To frabricate PV modules more sustainably and comply with the European regulation for the Restriction of Hazardous Substances (RoHS) Directive, lead should be eliminated from the solder alloy currently used in PV mass production. Today the near-eutectic alloy Sn60Pb40 (60 wt% tin, 40 wt% lead) is generally used to form the solder joints on the solar cell electrodes as well as for the cross connection, or bussing, of the cell strings to realize the string connection in the module. For a full-size PERC module, between 10 g and 15 g of Pb is needed, depending on the cell format, metallization type and interconnection design.

Lead-free Soldering on Industrial Stringers

Due to their reduced liquidus temperature, the use of lead-free solder alloys can lower the process temperature of industrial stringers by ≥ 50 K. This corresponds to a reduction in power consumption of up to 10 % compared to soldering with Sn60Pb40, depending on the solar cell architecture, solder alloy and equipment. To guarantee a homogeneous soldering result over the whole wafer, precise temperature adjustment during soldering is required. Also, a well-selected hardware of the industrial stringer (e.g., down-holding unit, heat source, temperature control, etc.) and suitable flux are essential. Activation of the flux, liquidation of the solder alloy and wetting of the metallization have to be optimized hand-in-hand. With our flexible industrial stringer equipment and profound knowledge of soldering solar cells, Fraunhofer ISE develops low-temperature soldering processes for all cell formats and cell technologies. These are accompanied by an extensive characterization of the solder joint properties on string and module level.