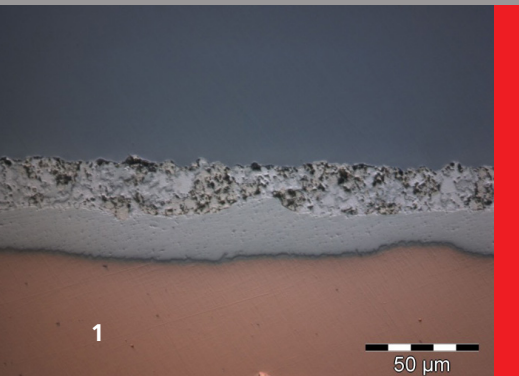




FRAUNHOFER CENTER FOR SILICON PHOTOVOLTAICS CSP



1 *Light microscopy cross section of solder cell contact.*

2 *Wetting balance tester for measuring wetting force of solar cell metallizations.*

3 *Pull tester to measure mechanical strength of soldered Cu ribbons of stringed solar cells.*

## INTERCONNECTION TECHNOLOGIES IN PHOTOVOLTAICS

### Research Area

At Fraunhofer CSP, various materials and methods are available to evaluate the joint formation of the cell to ribbon interconnections.

By non-destructive as well as destructive test methods, the varying interconnection technologies for solar cell string assemblies are evaluated and analyzed. Thereby the know-how of the fields of microelectronics, automotive, power electronics, etc. are combined with the competencies of evaluating the contact reliability of individual component levels in packaging of integrated circuits towards photovoltaics.

### Topics

- Evaluation and optimization of solar cell interconnection processes
- Analysis and validation of interface and material interaction
- Estimation of contact reliability
- Development of destructive and non-destructive testing methods
- RoHS compliance: lead free vs. leaded Cu ribbons
- Cell interconnection processes for new cell technologies: bifacial cells, back contact cells

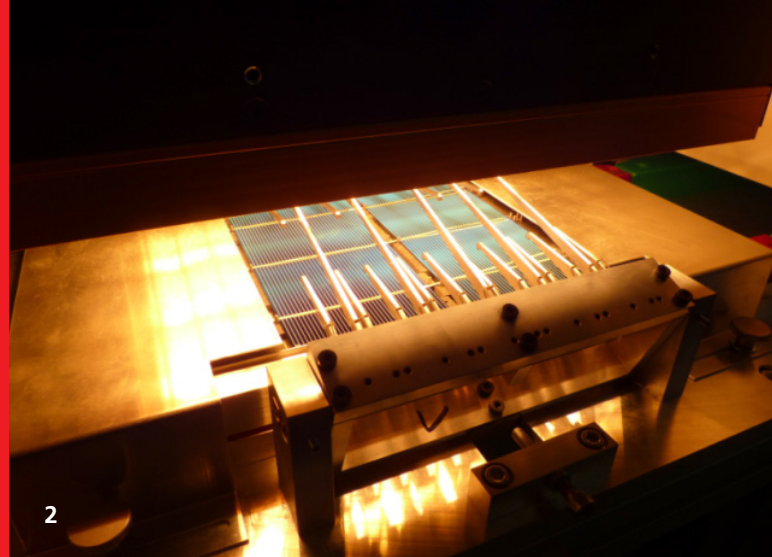
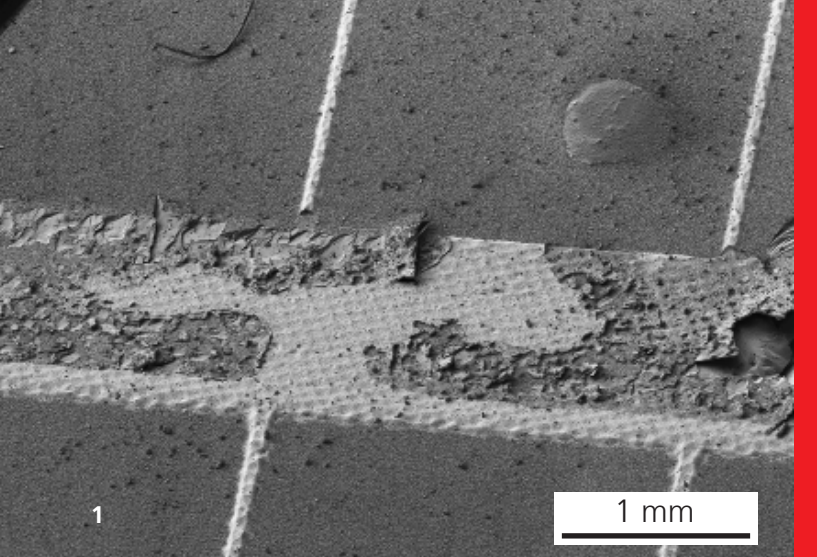
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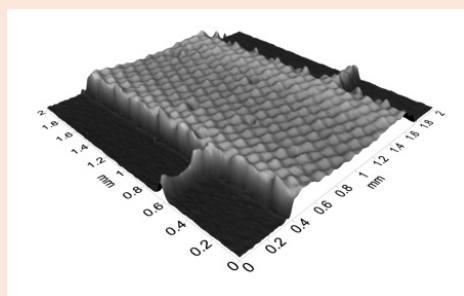


## Equipment

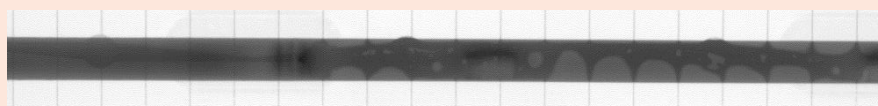
- Cross section preparation tools for specimen make for microstructure analyses
- Cross section analysis by light microscopy, SEM, etc. incl. material compound analysis and formation (DIC; POL, EDX, etc.)
- Characterization of time and temperature dependant material behavior of interconnection materials (TMA, DMA, DSC, TGA)
- Contact angle measurement equipment for static / dynamic measurements of contact angles and surface tension
- Wetting balance tester for logging wetting force time progression
- Pull- / shear tester for evaluation of the mechanical strength of PV contact structures
- Ultrasonic microscopy and x-ray scanner for non-destructive analysis of interconnection interfaces and contact formation
- Assembly and soldering stations for test applications and specimen production on cell and module level
- Laser profilometer and confocal white light microscope for surface structure analyses of cell metallizations, etc.

## Publications

- Schindler, S., Mueller, M., Wiese, S.; Investigation of the undercooling of SnCu solder spheres, Electronics System-Integration Technology Conference (ESTC), 2014 , vol., no., pp.1,7, 16-18 Sept. 2014
- Sebastian Schindler, Fraunhofer CSP, Halle, & Michael Volk, SCHMID Group, Freudenstadt; Multi-busbar technology: Increased module power and higher reliability at lower cost; Photovoltaics International; March 2014; 23rd Edition
- Schindler, S; Schneider, J.; Pönisch, C.; Nissler, R.; Habermann, D., Soldering Process and Material Characterization of Miniaturized Contact Structures of a Newly Developed Multi Busbar Cell Metallization Concept, 28th European Photovoltaic Solar Energy Conference and Exhibition, pages: 480 - 483, 30 September - 4 October, 2013, Paris, France
- Schindler, S.; Schneider, J.; Klengel, R.; Petzold, M., The impact of material composition and process parameters on the cSi solar cell interconnection, Electronic System-Integration Technology Conference (ESTC), 2012 4th, vol., no., pp.1,6, 17



3 3D visualisation of the solar cell bus bar front side metallization.



4 X-ray imaging of Cu ribbon busbar interface for analysis of solder wetting and void formation.

1 SEM analysis of fracture interface after pull test.

2 Soldering unit of the tabber stringer equipment.