438 Refined PV: Reduction of Losses by Ultra Fine Metallization and Interconnection of Photovoltaic Solar Cells

Project duration: from 07.2017 to 06.2020
Report submitted: 09.2020

Publishable Summary

In the last decade, major improvements in crystalline solar cells have been achieved by successively increasing emitter sheet resistance and reducing finger width and finger distance on the cell, allowing for decreased recombination, absorption, shading and resistance losses. While the reduced width could partly be compensated by a better aspect ratio of screen printed fingers, the trend to narrower fingers had to be additionally supported by an increased number of bus bars, from five to six or even twelve. A further prerequisite was the reduction of specific contact resistance to high ohmic emitters. While contact resistance of actual pastes would allow for a further shrinking, screen printing faces difficulties to keep pace. And for classical soldering, more than six ribbons seem not to be feasible.

Utilight has demonstrated an ability of printing high aspect ratio ultra-fine finger lines, see Fig. 1 and 2 with their Pattern transfer printing (PTP) technology. In this project the partners ISC Konstanz and Utilight showed that PTP enables finger widths down below 20 µm and aspect ratios above 0.5 using thick film silver paste. The influence of PTP process parameters, i.e., laser power and trench geometry, on the finger geometry and the print quality have been investigated in detail. Compared to conventional sceen printing techniques, paste consumption could be lowered by approx. 54% and the cell efficiency could be increased by up to 0.13%. Progress was made in metallization paste adaptation for PTP printing process. Good contact could be formed from fingers with cross section of only 200 µm².

Meyer Burger has developed the Smart Wire Connection Technology (SWCT™) further, which interconnects cells with a multitude of wires, see Fig. 3. Merging both PTP and SWCT™ in the project was one of the main goals. On Meyer Burger's side, advancements in SWCT™ with Indium-free wires were made, which enabled the feasibility and cost reduction of this technology with PTP metallized cells. Wires became 50% cheaper with this new alloy. The flexibility of SWCT™ to various module designs was tested and advanced (e.g., 72-cell and half-cell modules). The maximum reached module power with these cells was 310 Wp (Watt peak). The reliability of the modules was tested in climatic chambers (PTC: power thermo cycling, DH: damp heat, HF: humidity freeze). Most modules passed 200 PTC cycles (1 x IEC, <5% degradation), and 1000 h in DH (1 x IEC, <5% degradation). The results show that SWCT™ is able to connect effectively down to ≤20 mg of Ag on the cell front side.

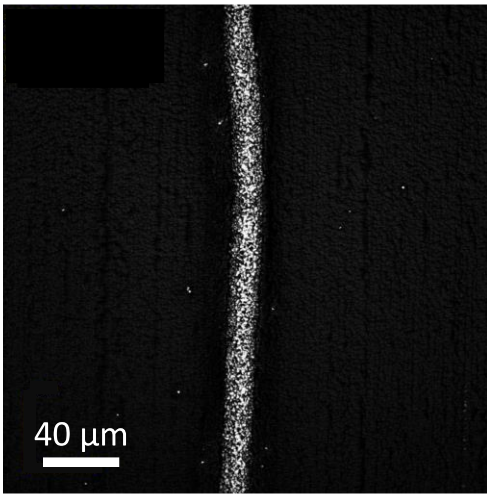

Fig. 1: LSM image of a ultra-fine line of around 15-16 µm width printed by PTP.

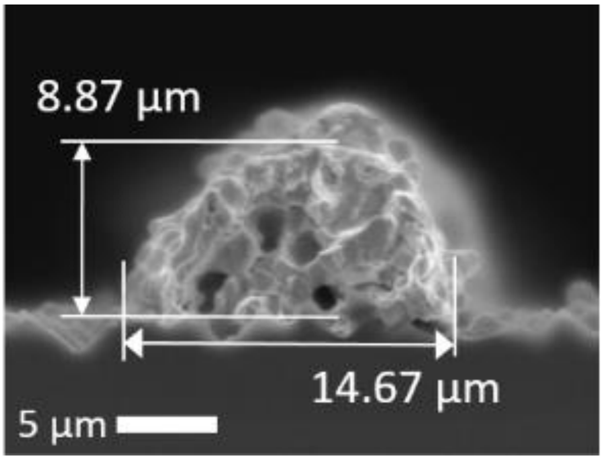

Fig. 2: Cross section of a ulta-fine line printed by PTP.

Fig. 3: Smart Wire concept developed by Meyer Burger.

Project consortium

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Participating countries and financing:

Country	**Number of organisations involved**	**Project costs in EUR**	**Public funding in EUR**
Germany	1	1’200’755	960’604
Israel	1	475’580	237’790
Switzerland	1	1’000’000	400’000
Total	*3*	*2’676’335*	*1’598’394*