Distortion of Knotless Printing Screens in mass production

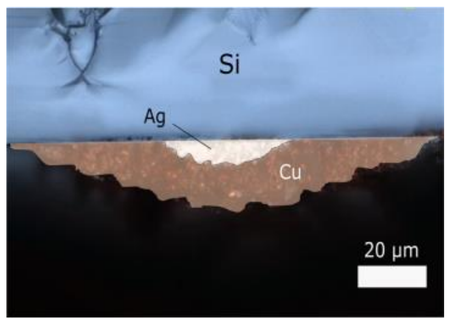
Mertcan Comak[1], Jan Lossen[1], Nagesh Chikkaiah[2], Shamil Ollakkan[2], Mohanraj Chandran[2], Lejo Joseph Koduvelikulathu[1]

[1]ISC Konstanz e.V., Rudolf-Diesel-Str. 15, 78467 Konstanz, Germany,
[2]TATA Power Solar Limited, Electronic City Rd, Phase 2, Bengaluru, Karnataka 560100, India
corresponding author: mertcan.comak@isc-konstanz.de / +49-7531-36183-554

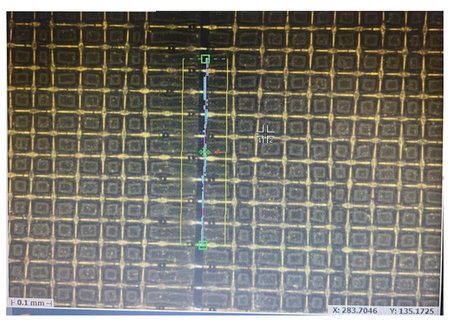
Motivation: Precise Print-on-Print for Cu-TOPCon Cells

- Precise print-on-print metallization of front and rear contact on Cu-TOPCon cells [1]
- T. Misaki studies with calendered mesh 520-011, displacements of 25 µm were found[2]
- Quantifying the extend knotless screen expands during production and to determine the required security margin (protrusion) to match 2nd (L2) on 1st print (L1) during its lifetime

Security Margins between Ag Contacts and Cu finger

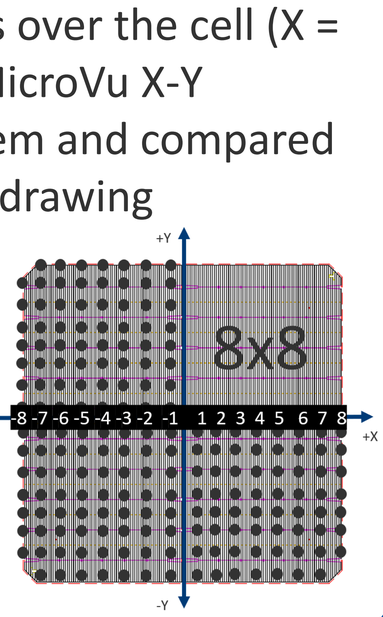


Ag contact coated with Cu finger[3]



Knotless mesh bending after 35k print

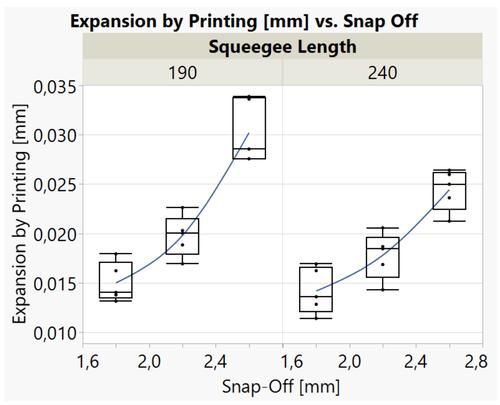
Characterisation



Micro-Vu Vertex 341 Microscope

Impact of Snap-Off and Squeegee Length on Printing Expansion

- **Snap-Off:** Expansion between the printed image and the screen pattern increases as snap-off rises
- **Squeegee Length:** Longer sq. reduces expansion, particularly at higher snap off values



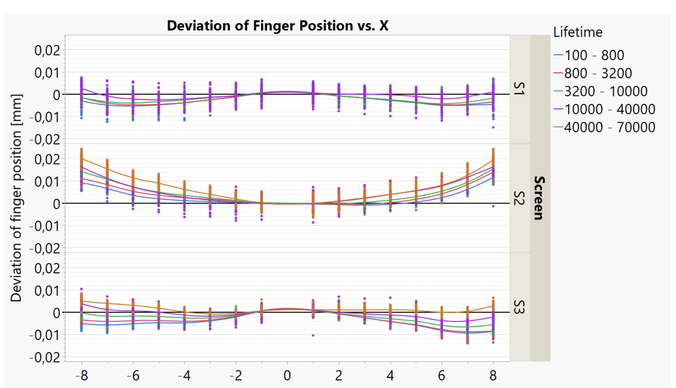
First to end finger expansion on M6 wafer size (166mm)

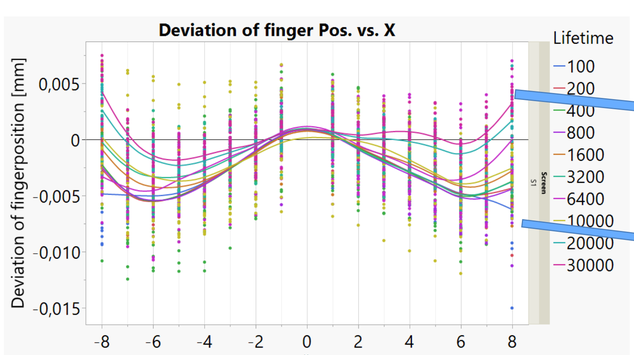
Measurement Details

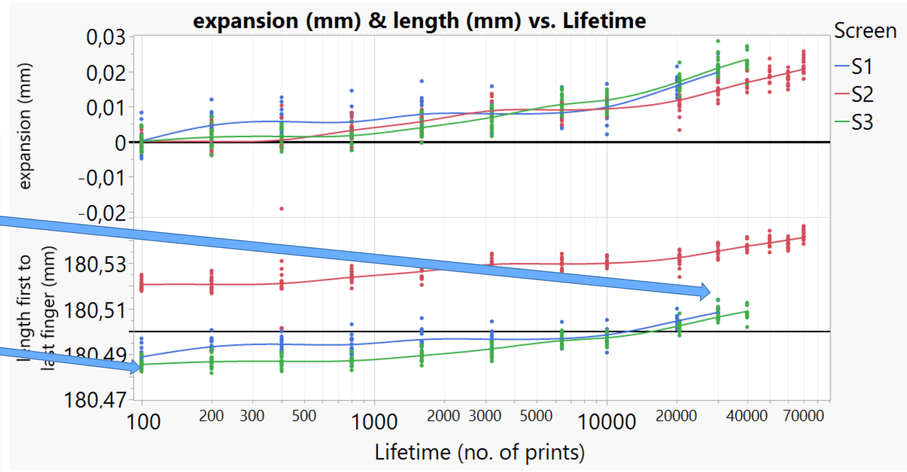
- Conducted at 16 x 16 positions over the cell (X = -8 to 8, Y = -8 to 8) using the MicroVu X-Y coordinate measurement system and compared with nominal values of screen drawing
- Investigated 3 screens (480-11,with PI –layer) over full lifetime of up to 70k prints in mass production at TPSL.
- Analysis of printed images using the defined coordinate measurement system

Screen Expansion over Lifetime

- Screen gradually expands over lifetime
- Expansion (first-to-last finger) by wear out is relatively low :
  + 10 µm after 10k prints, + 20 µm at end of life (@30k to 70k prints)
- Expansion over time is similar for all screens; however, initial distances were different







Conclusions

- With state-of-the-art knotless screens (mesh 480-011 with PI emulsion) double print seems feasible.
- If screens for first (L1) and second (L2) print are matched at the beginning, the two printed images should never deviate more than 10 µm from each other.

References

[1] J. Lossen et al., Proceedings of SiliconPV 2024,
[2] T. Misaki , et al., 11th MIW, 2023
[3] N. Chen et al., Sol. RRL, 2023

Acknowledgements

This work was partly funded by German federal ministry of economic affairs and climate action under grant agreement No. 03EE1128A, “KONTRAST”