

Development and reliability of screen-printable fire-through Cu paste for passivated contact solar cells

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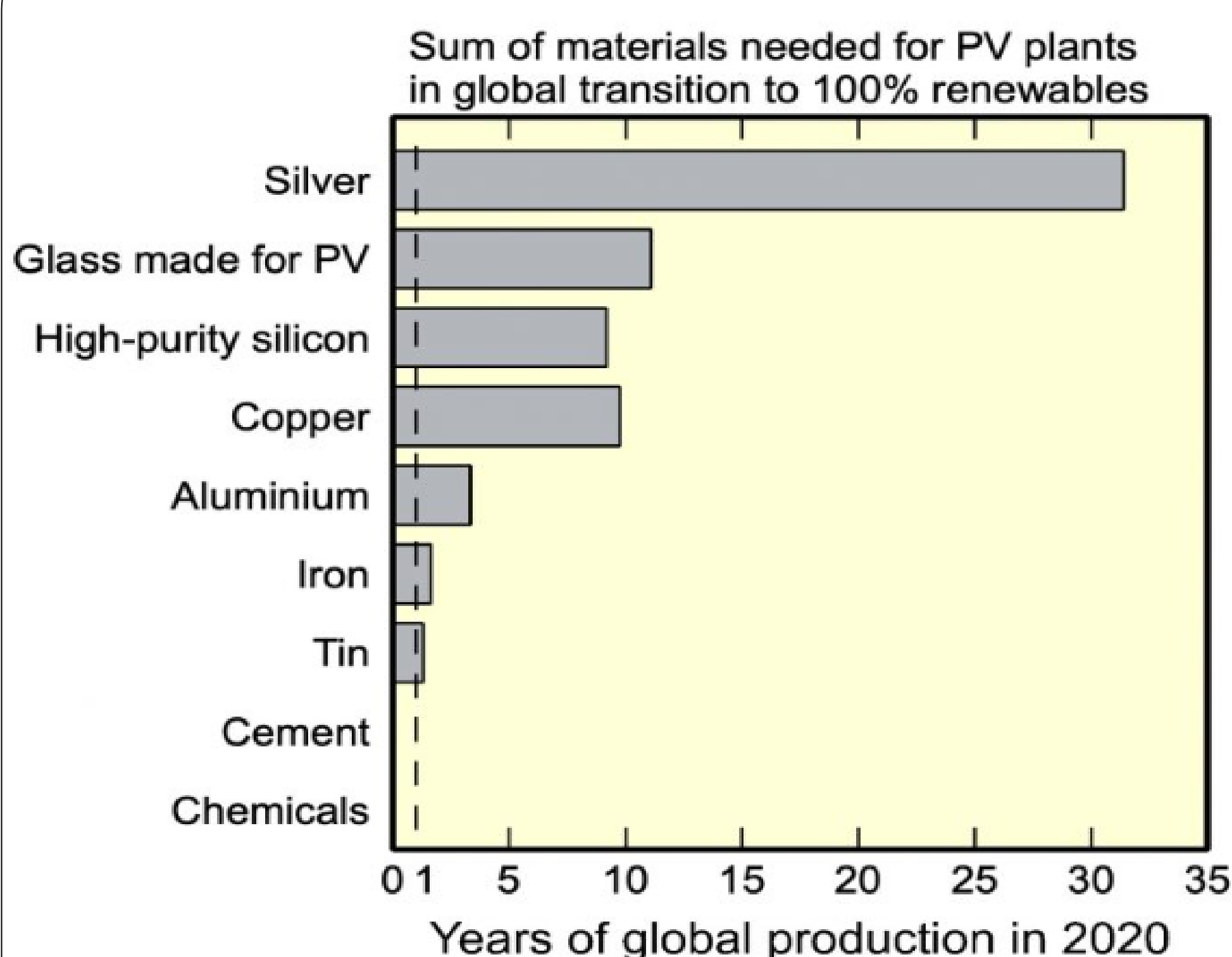
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Introduction



Advantages of Copper (Cu) Over Silver (Ag)

1. Bulk Cu has a similar conductivity to Ag ($1.7 \mu\Omega\text{-cm}$ for Cu, $1.6 \mu\Omega\text{-cm}$ for Ag)
2. Cu is ~100 times cheaper than Ag, making it an excellent potential replacement

Problems Associated with Copper (Cu) Contacts

1. Easy oxidation
2. Diffusion into the Si cell and recombination activity

<https://www.changeanyway.com/is-solar-electricity-sustainable/>

For 40 TW of PV required to transition our planet to 100% renewables, the silver (Ag) should disappear from PV production.

Fabrication of SE-PERC solar cells

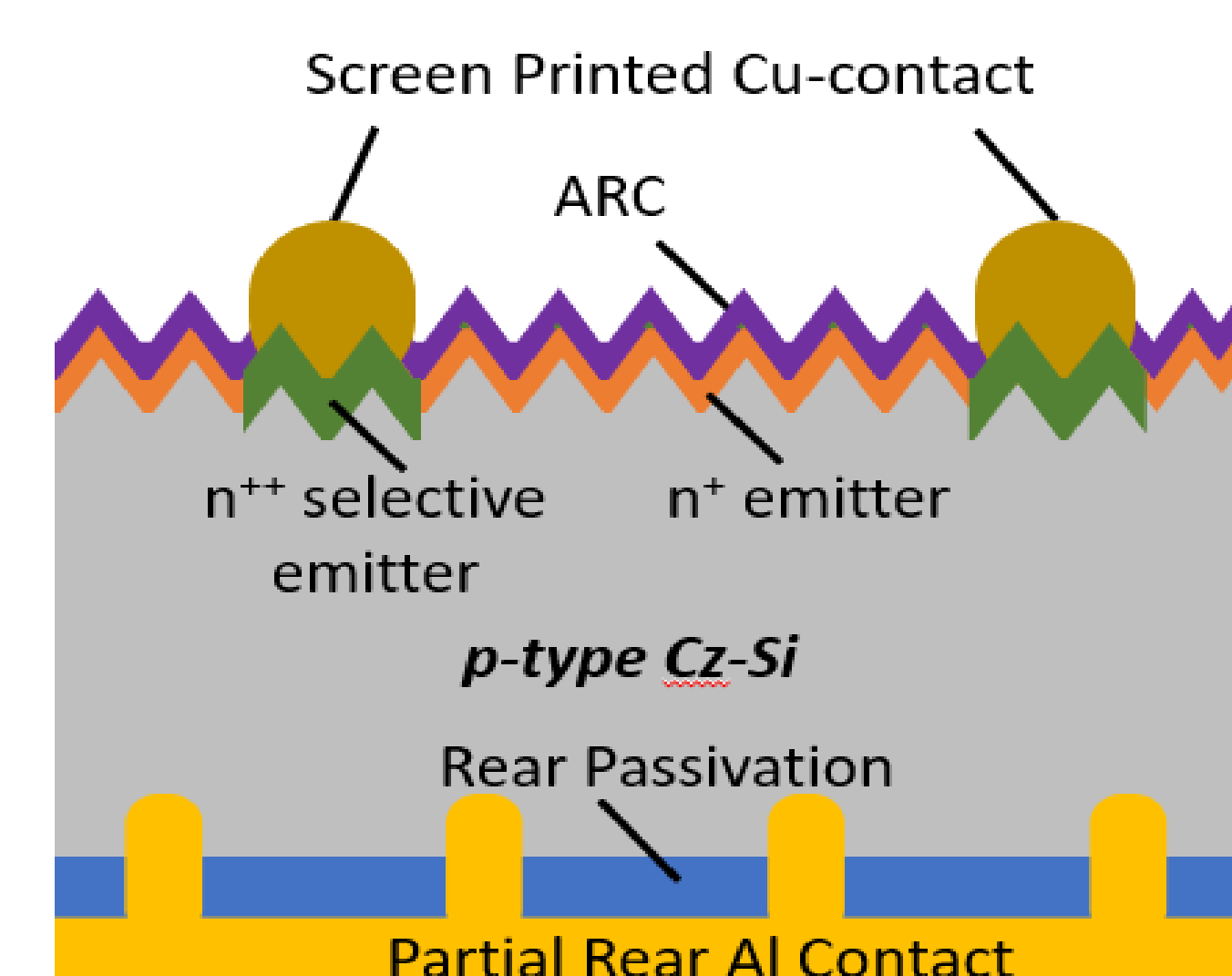


Fig. 1 Schematic diagram of Selective Emitter Passivated Emitter Rear Contact (SE-PERC) solar cell

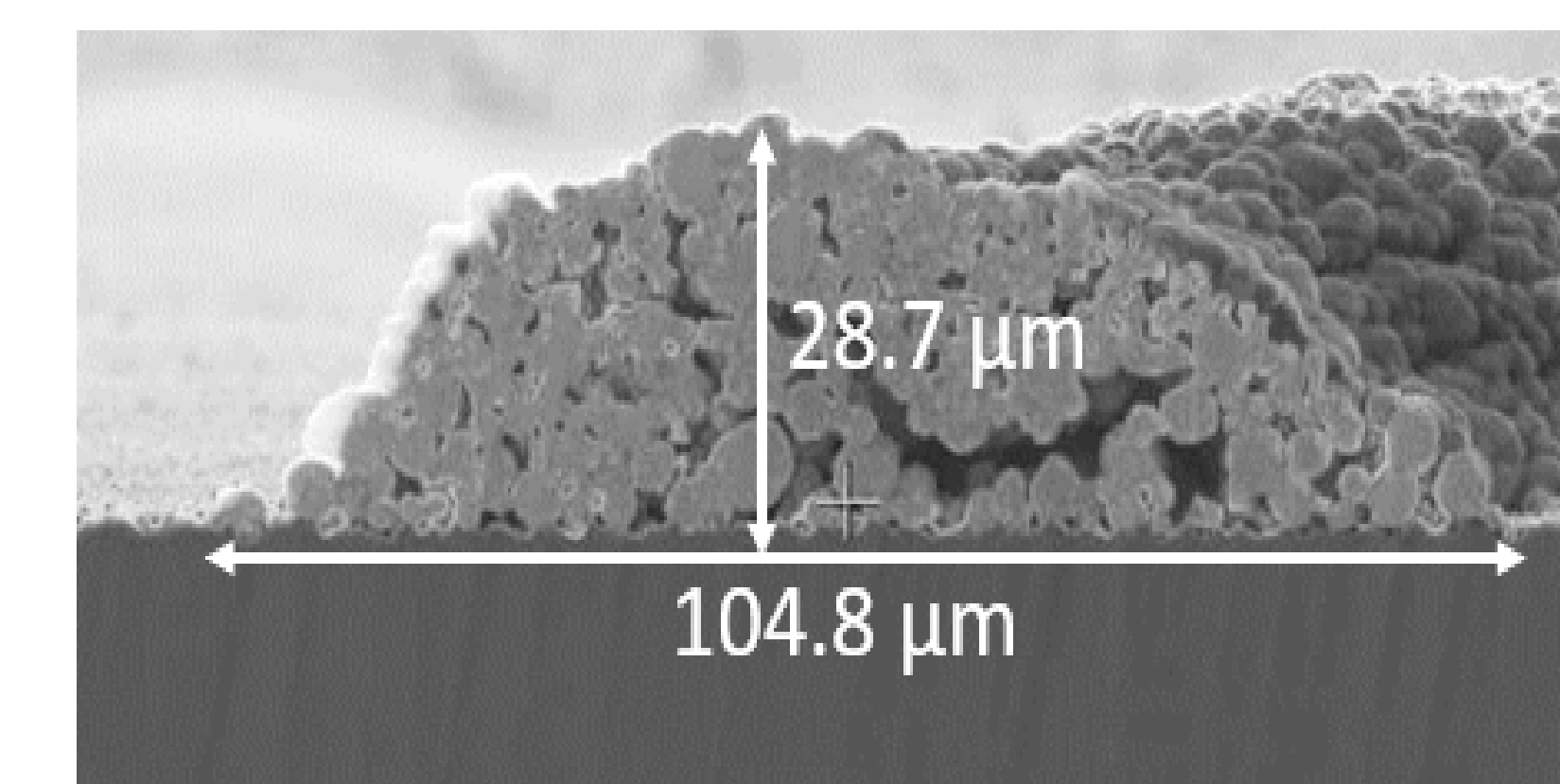


Fig. 2 SEM image of Cu finger

Selective emitter PERC cells

- M6 sized (166 mm × 166 mm) monocrystalline p-type wafers.
- Front grid screen-printed with Cu paste and partial Al contacts at the rear side.
- Peak firing temperature varied as the paste constituents were changed

Characterization of SE-PERC cells based on development of Cu paste

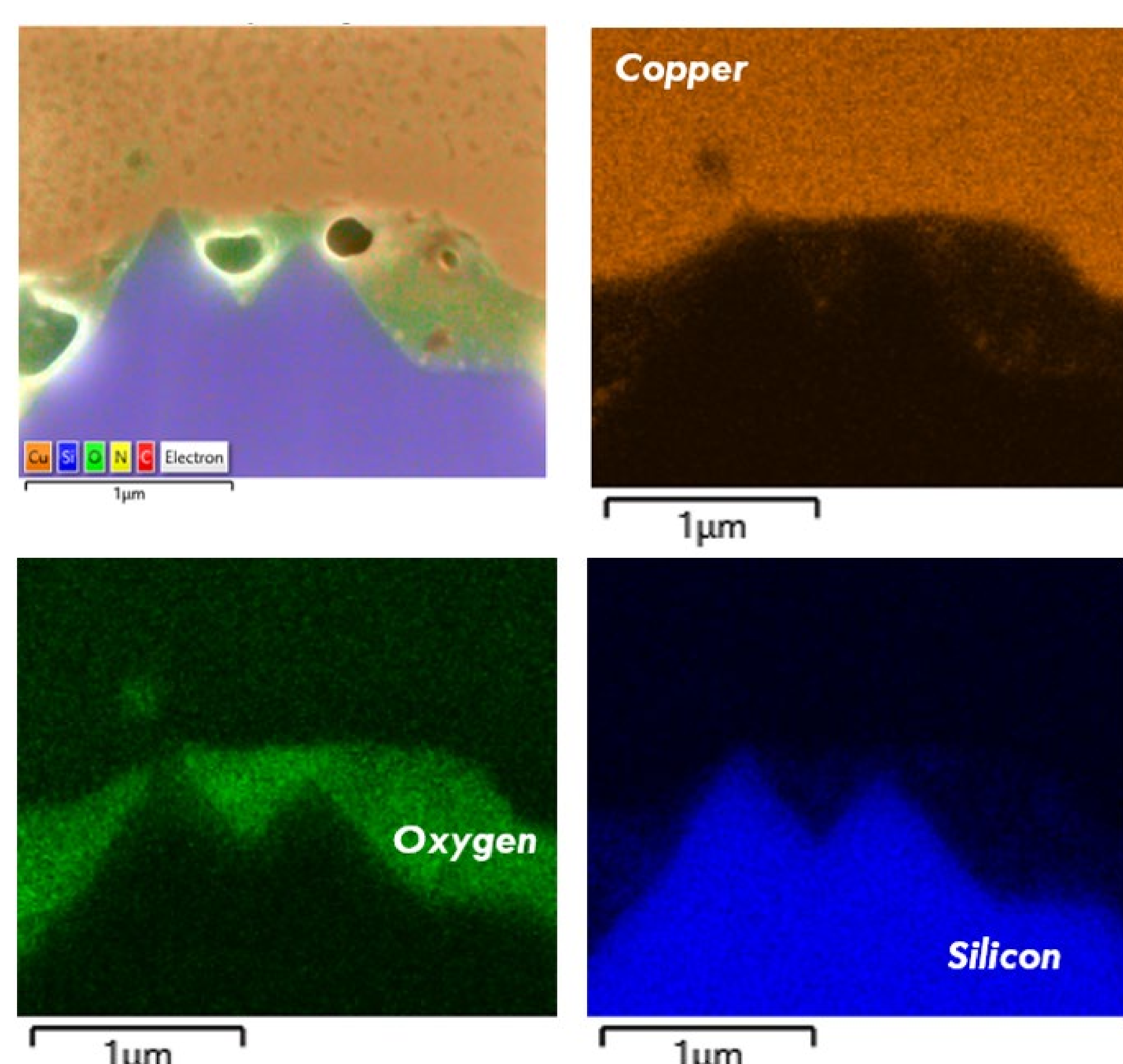


Fig. 3 EDS of initial version of Cu paste showing thick oxide layer between Cu and Si

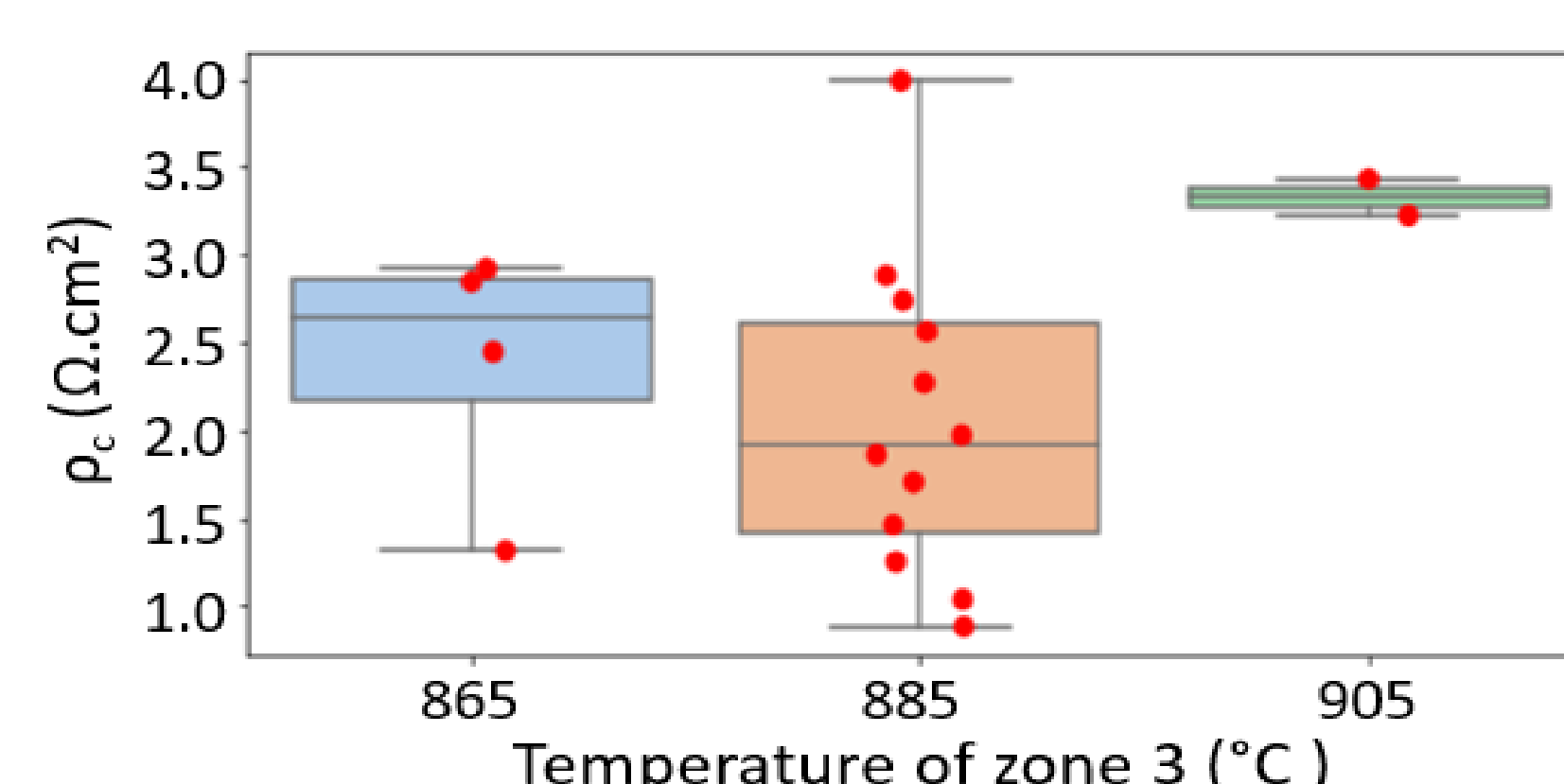


Fig. 4 Contact resistance (ρ_c) after firing at different temperatures for initial versions of the Cu paste

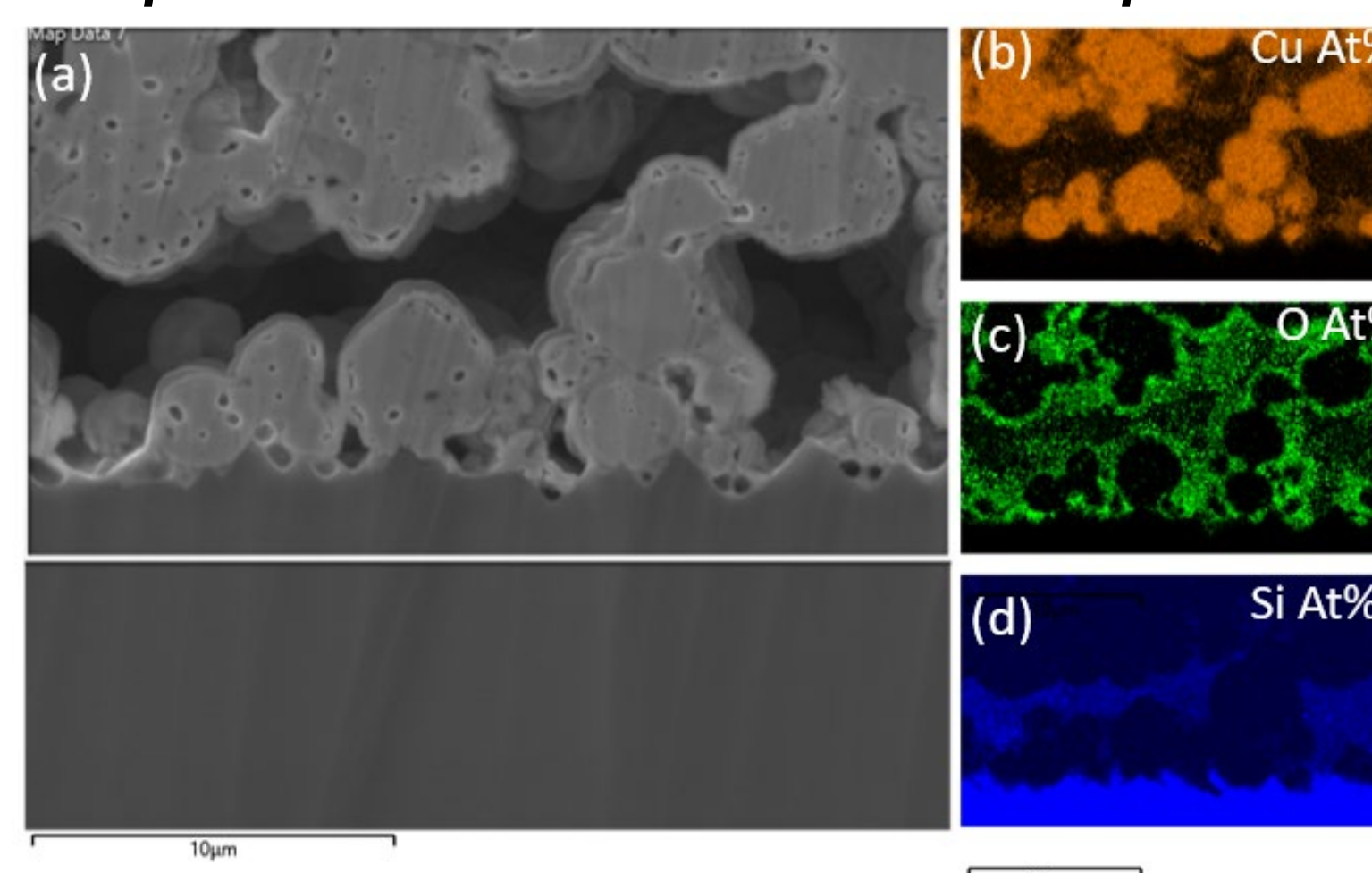


Fig. 5 (a) SEM of screen printed and fired Cu paste (b), (c) and (d) EDS of Cu particles with oxide shell in advanced version of Cu paste

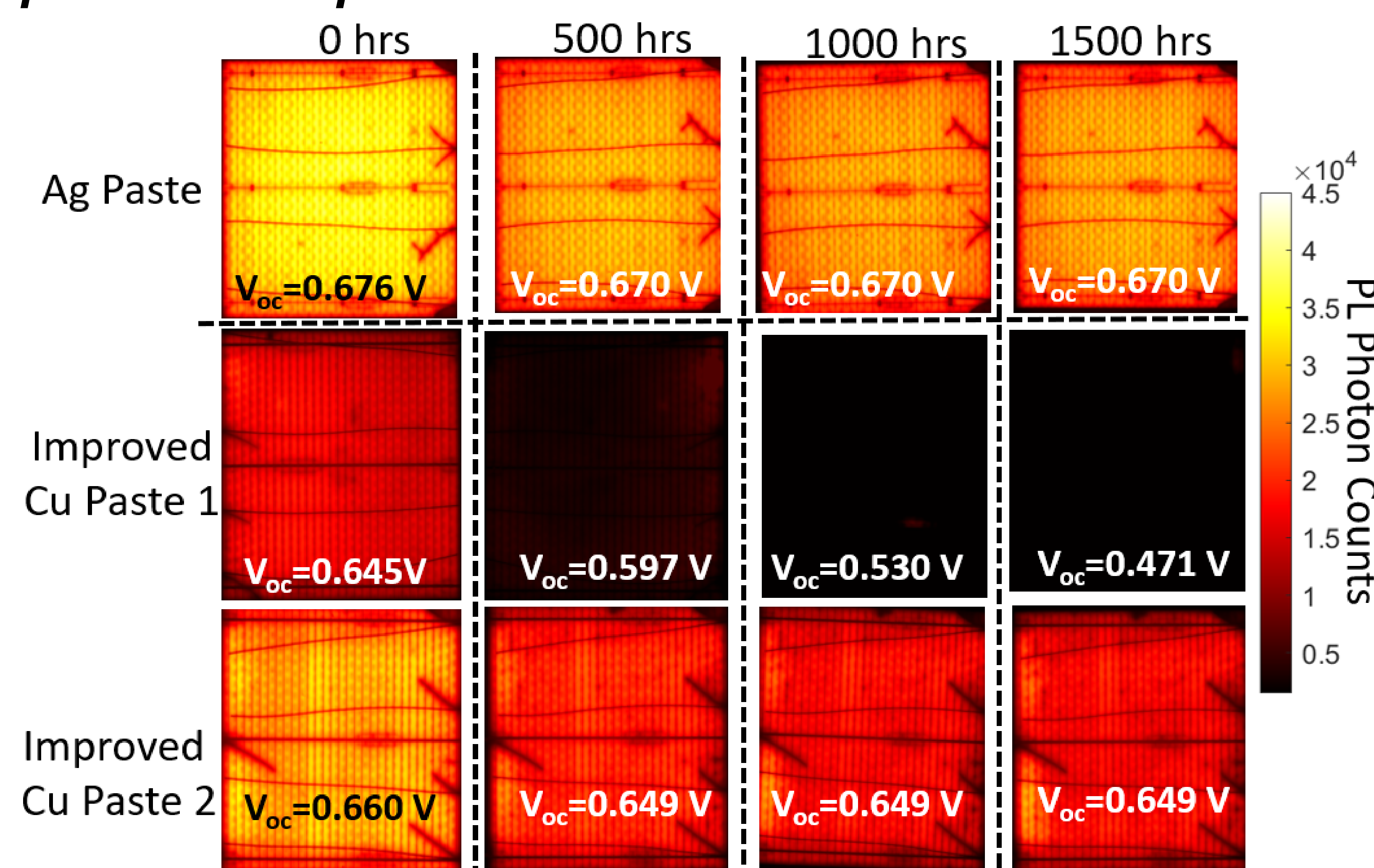


Fig. 6 PL images of mini-modules before and after accelerated tests (Damp heat 85°C/85% humidity)

Reliability studies of devices with advanced version of the paste

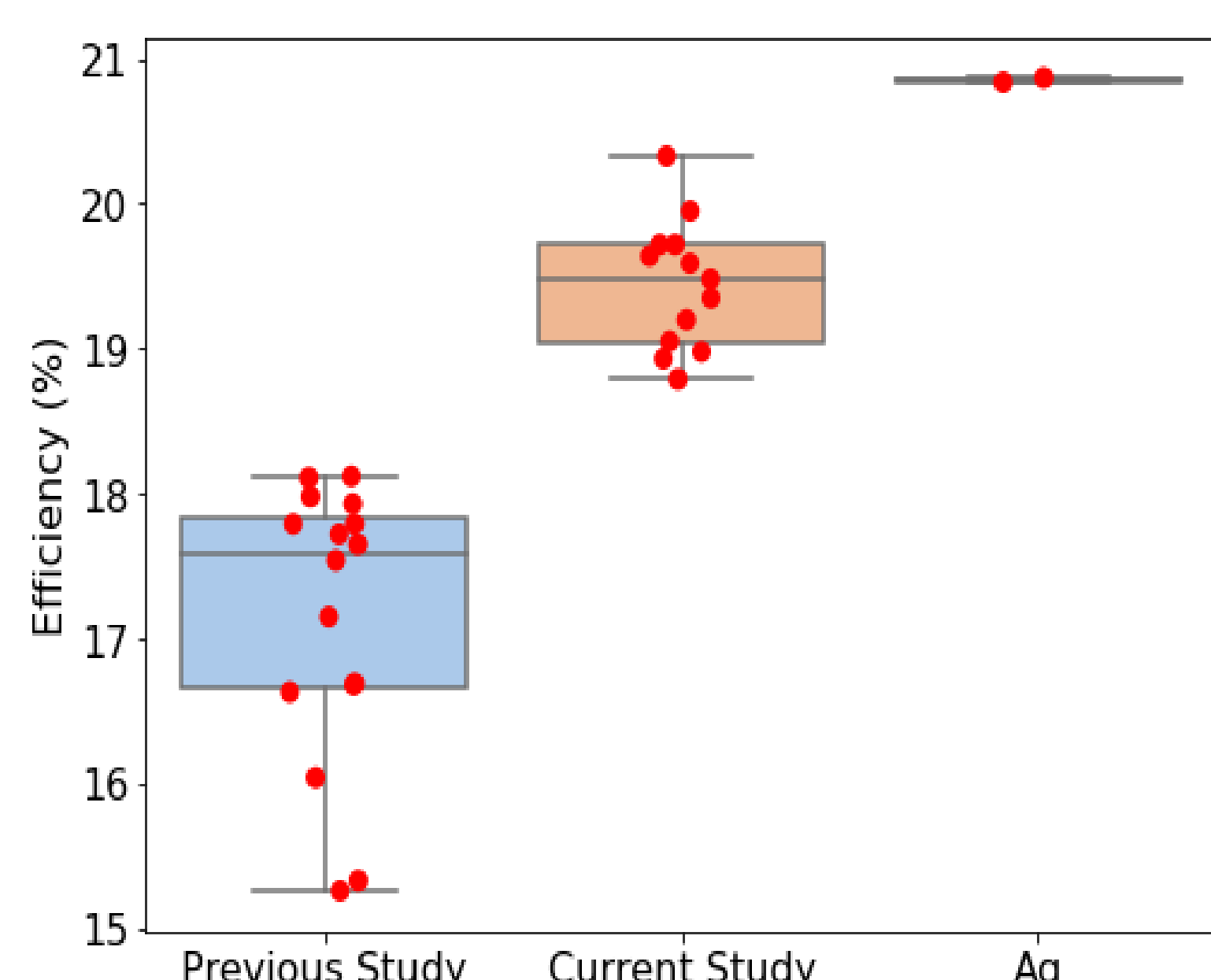


Fig. 7 Efficiency distribution of mini modules (4x4 cm² sized PERC cells) with advanced versions of Cu paste

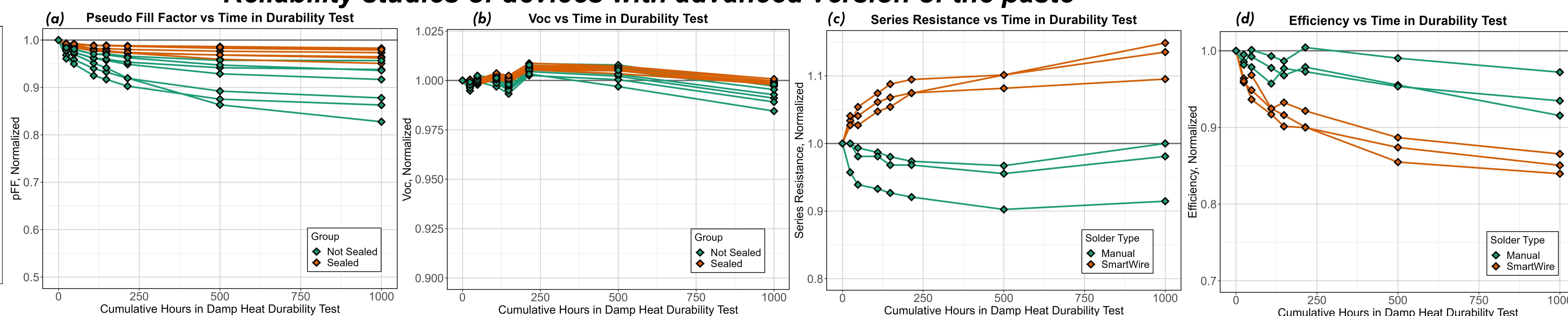


Fig. 8 Degradation of PERC solar cell parameters under damp heat testing for 1000 hours (a) Pseudo FF (b) Voc (c) Series resistance based on interconnecting method (d) Efficiency based on interconnecting method

Rear Interconnection: SnPb solder coated Cu ribbons were manually soldered to the Ag pads on the rear of 4 cm × 4 cm SE-PERC cells. **Front Interconnection:** Manual – SnPb solder coated Cu ribbons were manually soldered with a soldering iron to the Cu pads on the front of the cell. Smart Wire - The front contacts were connected using smart wire connection technology (SnBiAg coated Cu wires) which makes electrical contact during the lamination process. **Module:** Glass/Glass mini modules were constructed using 3 inch × 2.5 inch sized low iron solar glass and thermoplastic polyolefin (TPO) encapsulant. Sealed modules were constructed using a thermoplastic butyl edge sealant with desiccant around the inside perimeter of the module.

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