

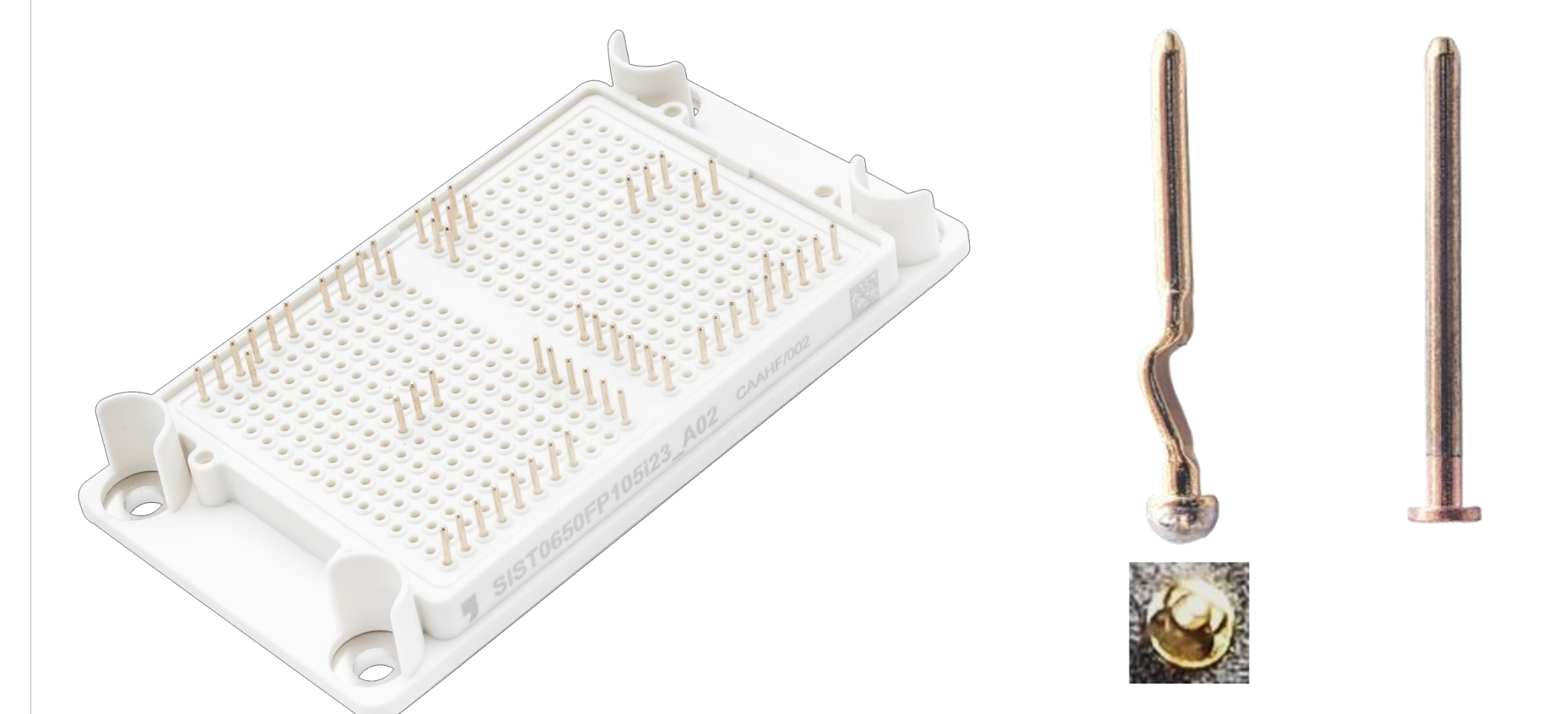
Reliability and Manufacturing Comparison of Flexible and Straight Pin Interconnects for Pin-Array Power Modules

S. Matthias¹, R. Schnell¹, Xu Quinn², Morax Wang², Ian Wang² and Coris Li²

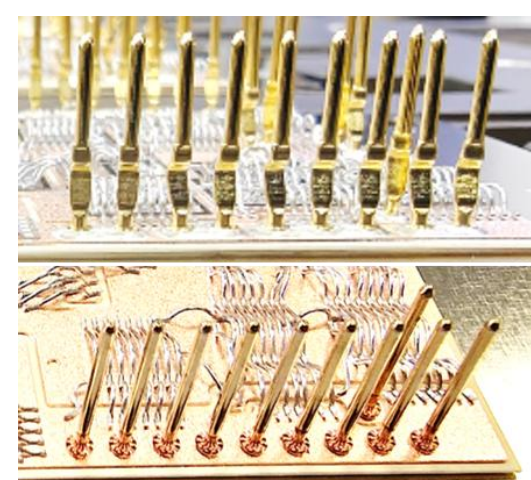
¹SwissSEM Technologies AG, Switzerland

²Sunking Pacific Semiconductors Technology (Zhejiang) Co. Ltd, China

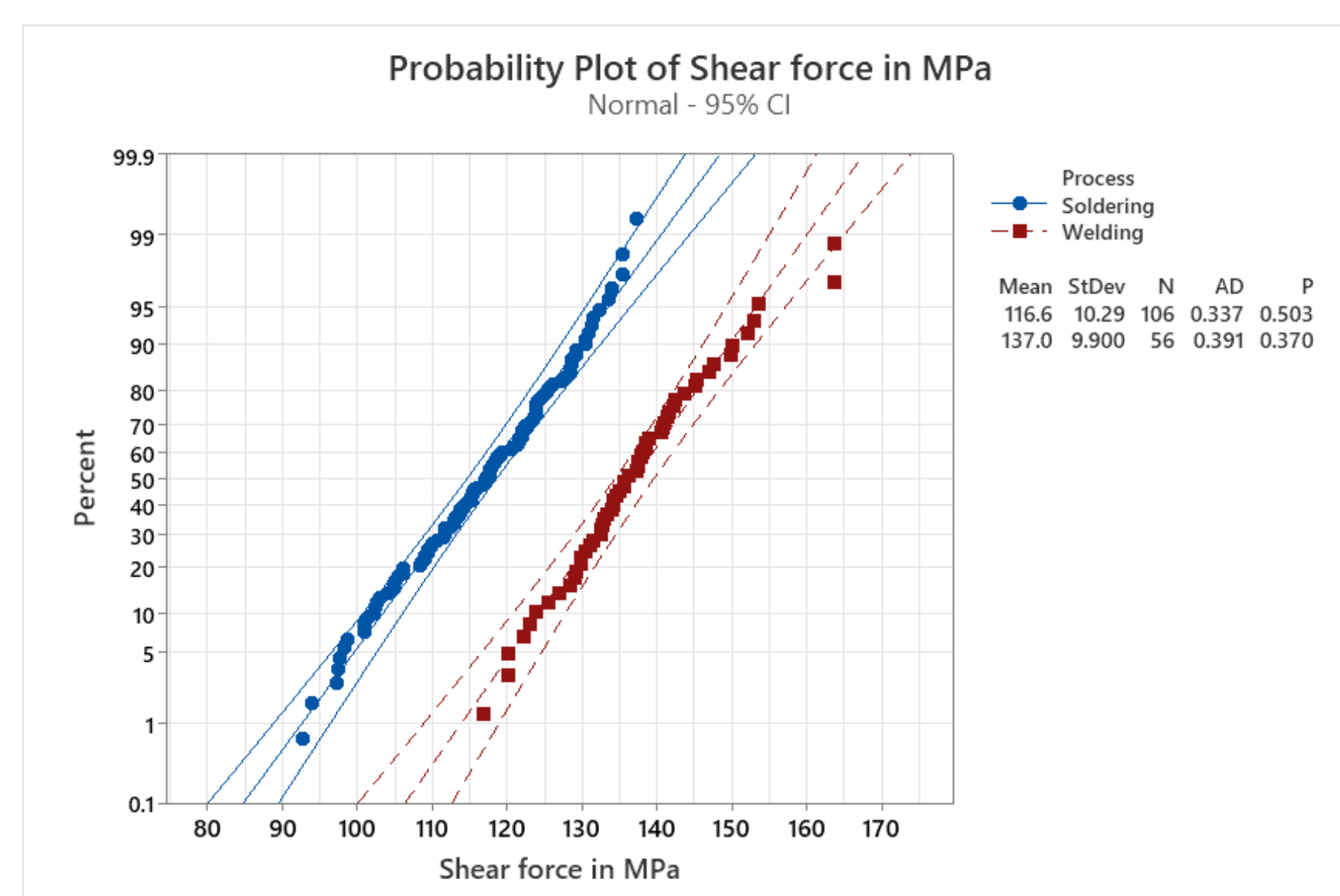
Motivation



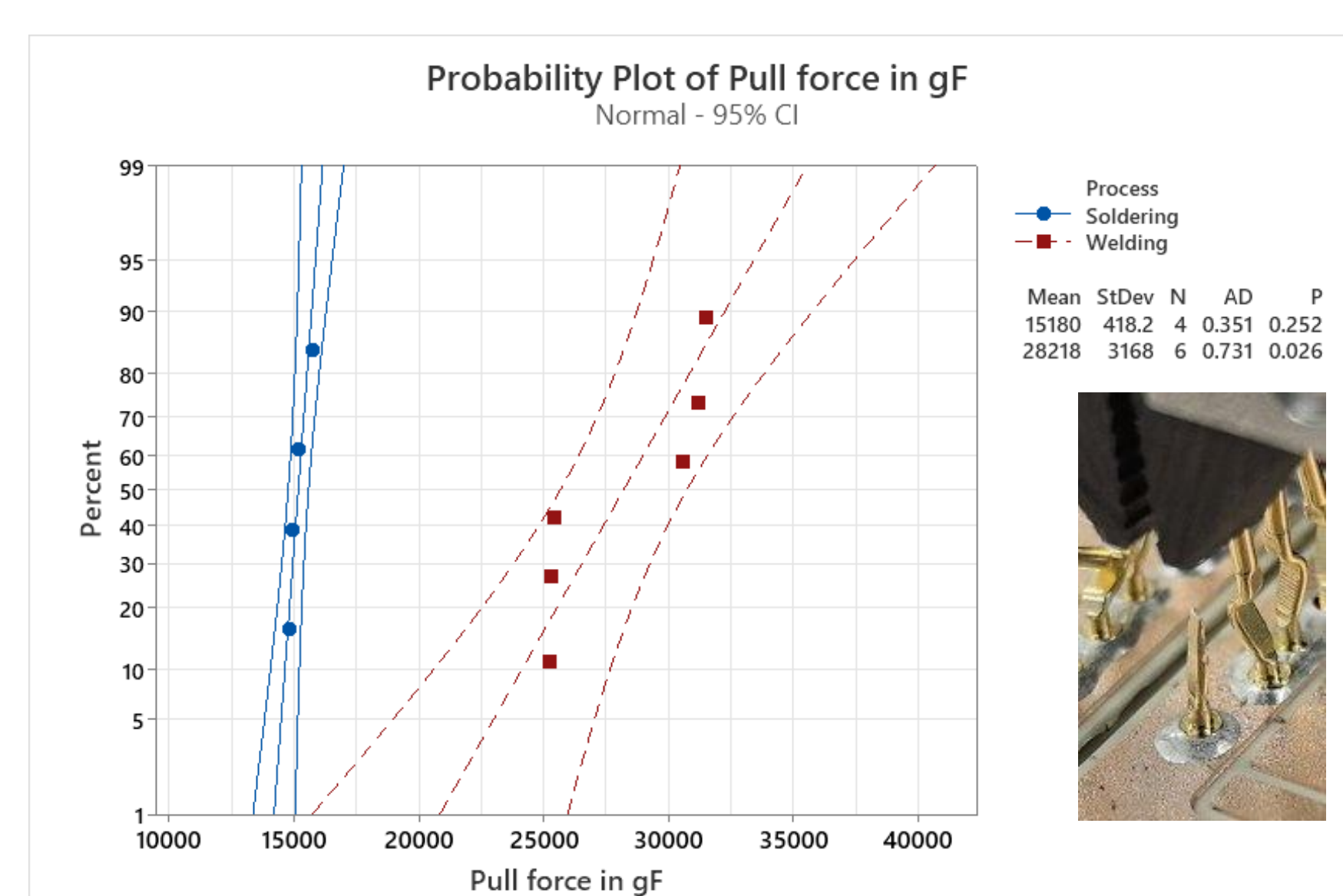
- Pin-array power module for photovoltaic and energy-storage applications
- Which pin is the best choice?
 - Processing (USW vs Soldering)
 - Reliability (Straight vs Flexible)



Processing



Shearforce comparison – higher shear for straight pin

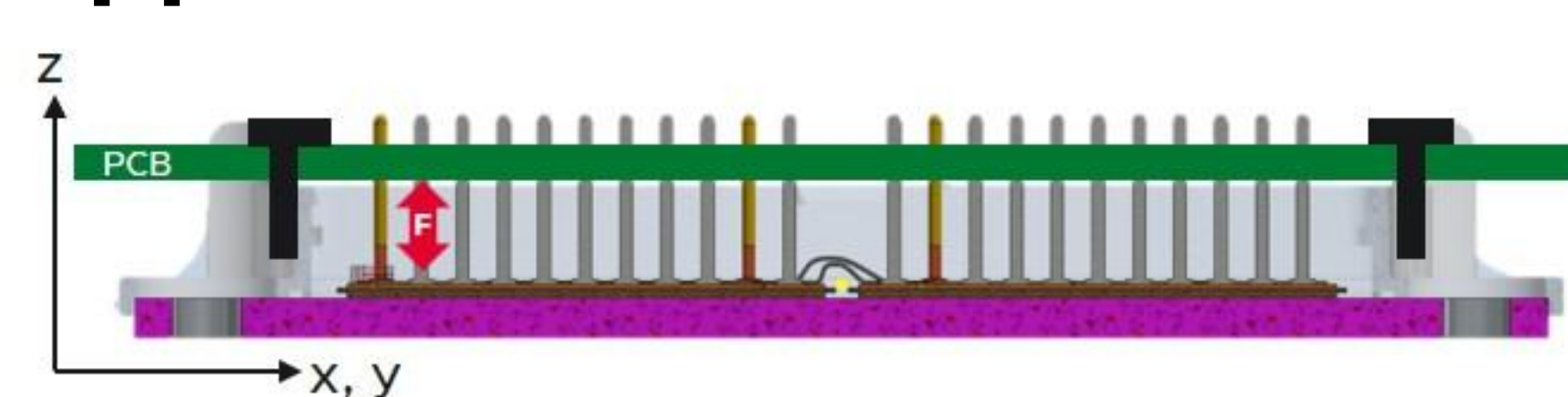


Pullforce comparison – higher force for straight pin – destruction limit (breakage for flexible pin)

Process details

- Straight pins can be & are welded – excellent individual process monitoring: Process stability and quality ensured for each individual pin
- Processing time pin-USW: ~3 pins/s → a full module done in ~20 s → no disadvantage to soldering
- S-shaped pin – batch like process – no individual process monitoring

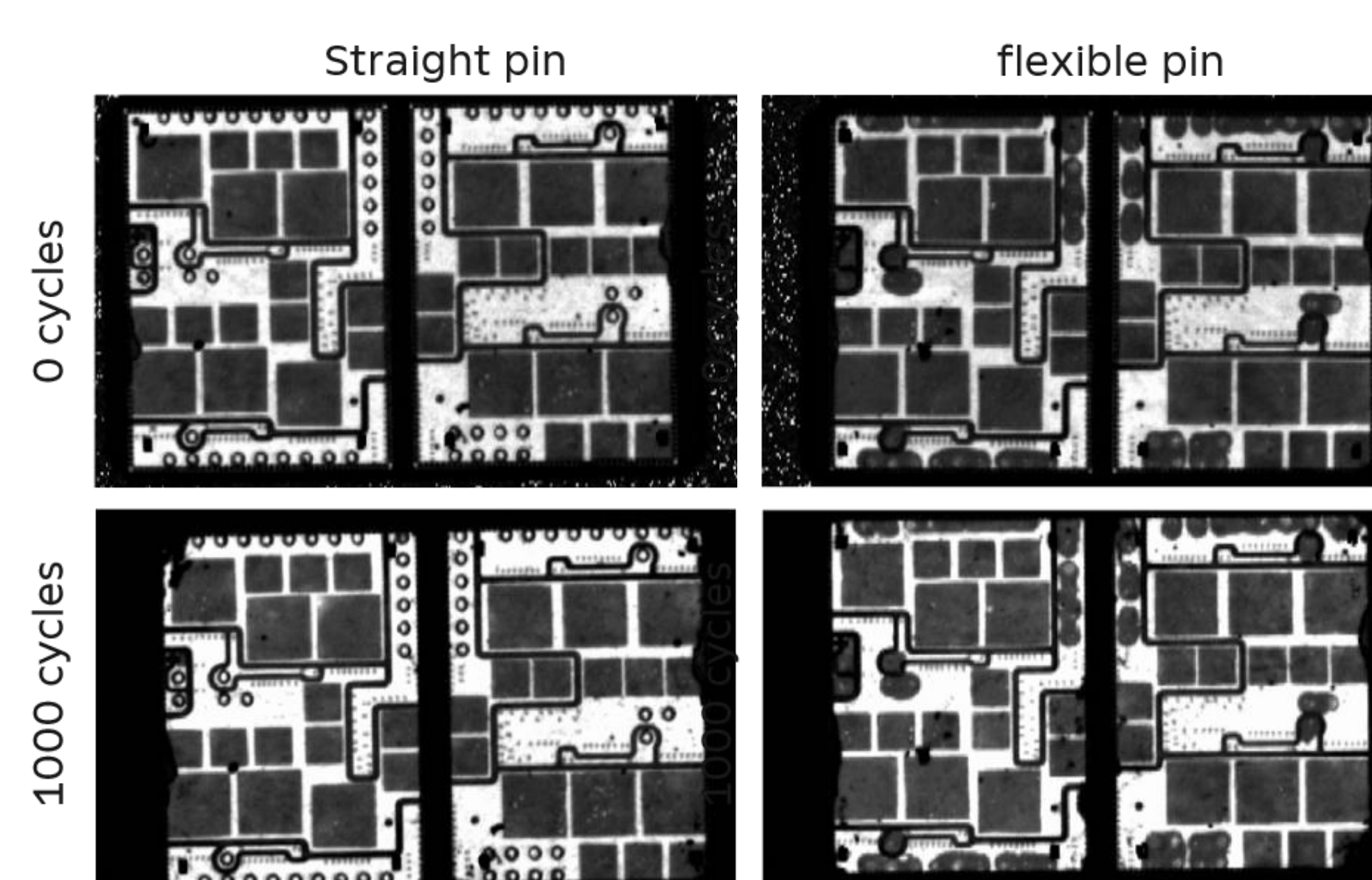
Application



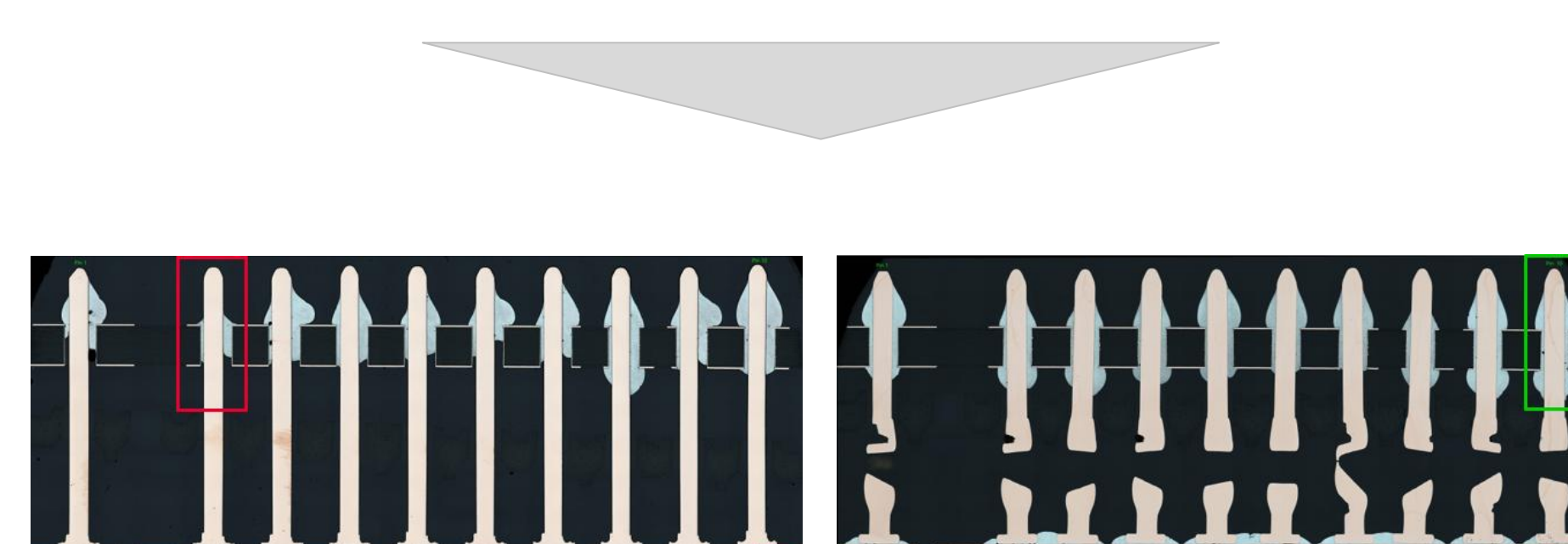
Schematic description of application conditions

- Critical pull and push forces due to thermal expansion of mounted PCB during temperature cycle
- Thermal-Shock-Test (TST) to simulate application conditions with soldered PCB to the various pin variants
 - 40 °C to 125 °C for 30 min each; 3s transition time for 1'000 cycles
- Manually soldered PCB to module

Reliability/Structural Results



CSAM inspection for pin variants – no degradation for both pin variants

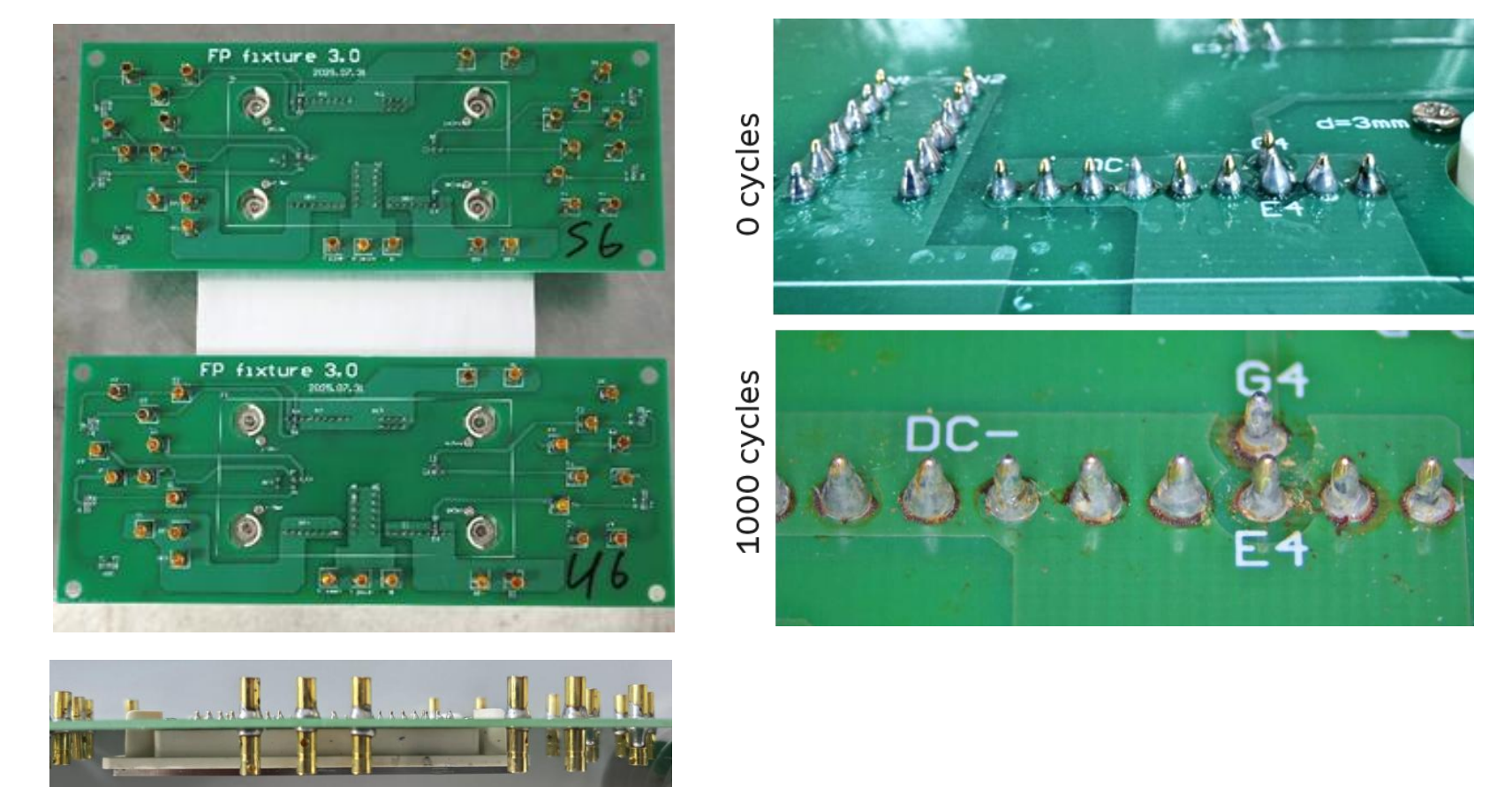


Cross-section analysis after 1'000 cycles TST

Important to note

- Cylindrical welding joint for USW-straight pin to substrate connection
- In contrast, fully soldered area below base for flexible-solder pin
- Only mild substrate delamination around the edges of the substrate after 1'000 cycles of TST
- No pin to substrate connection degradation for straight or flexible pin independently of pin variant

System after 1'000x TST

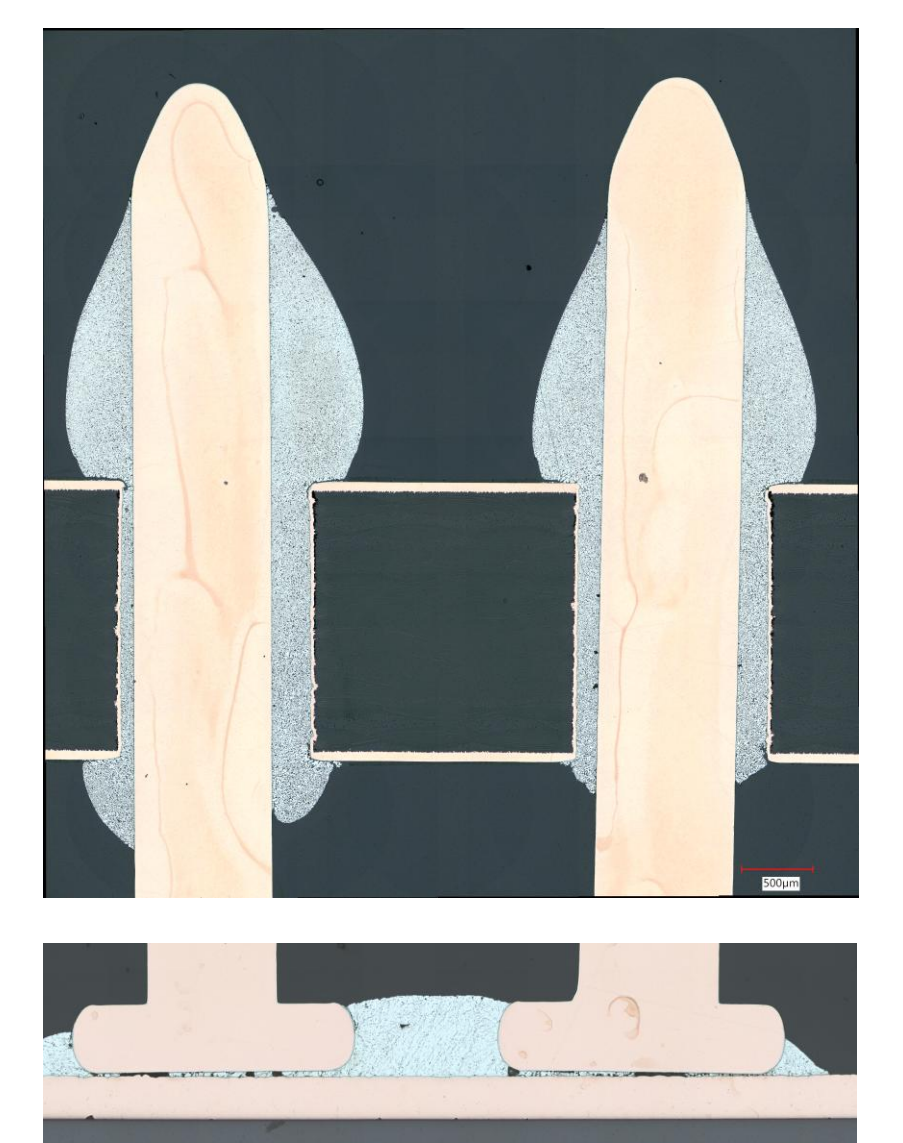


- Soldered PCBs to pins were – identical for both pin variants (straight and flexible)
- No electrical parameter degradation for both pin variants encountered
- Electrically – identical before and after TST

Straight – USW



Flexible – Solder



Close-up and high magnification photographs of pin to PCB soldering and pin to substrate joint after 1'000 cycles TST

Important to note

- Very small cracks around the solder at the edge of the solder of Pin to PCB
- Similar (uncritical) situation for both pin variants

Conclusion

- Pin-array power module for photovoltaic applications will work with both pin-variants reliably
- Straight USW pin offer better process monitoring and hence quality assurance compared to soldered pins
- The pure amount of around 56 pins on such an small area neutralizes the anticipated strong PCB induced forces