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Current Carrying Capability Limitations and Adaptions to New Requirements for Contact Springs

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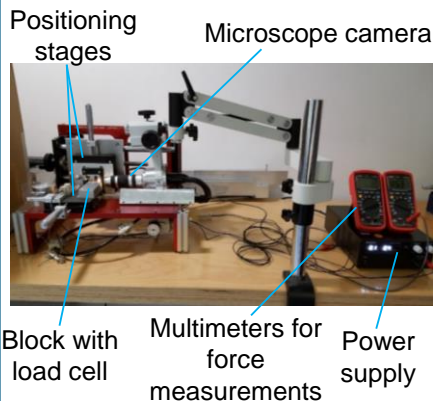
Introduction / Motivation

The current carrying capability (CCC) of contact elements are determined commonly in industry via force relaxation (International Sematech Manufacturing Initiative –ISMI method) and temperature rise method.

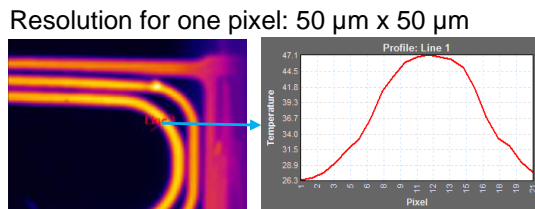
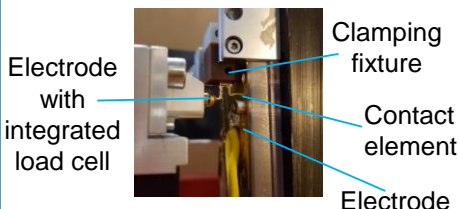
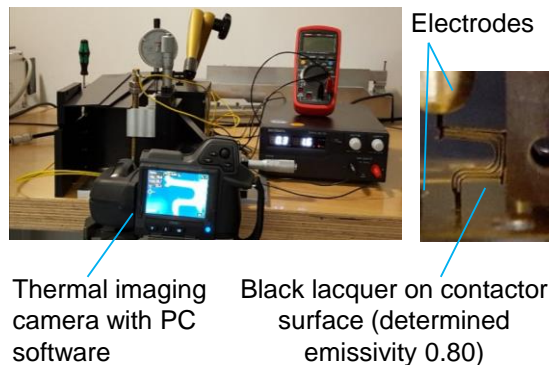
Both methods are compared in detail for miniaturized spring probes and cantilevers, respectively. We suggest which methods should be used for the contact elements. Furthermore, we show how to estimate the maximum temperature rises for various duty cycles with simple equations, if only a single measured value is known.

Test setups

ISMI method



Temperature rise method

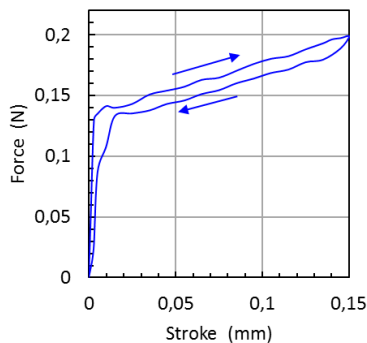


Spring probe

Conventional ISMI method

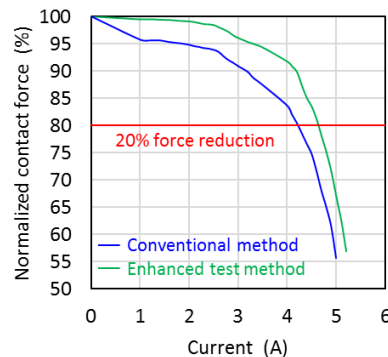


- Stroke is adjusted only once during the test
- Neglecting hysteresis behavior in force-stroke diagram
- Arising question: What is the true CCC value?



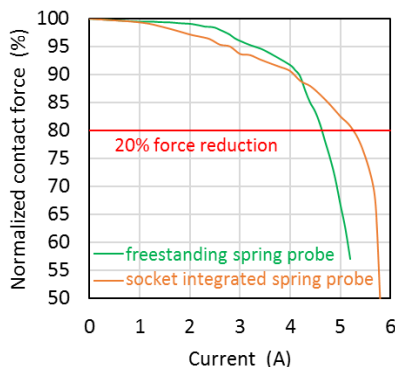
Enhanced test method

- Principle is the same like in the conventional ISMI method
- Exception: the stroke is reperfomed and the force is measured before applying the incremental current
- Hysteresis behavior is solved



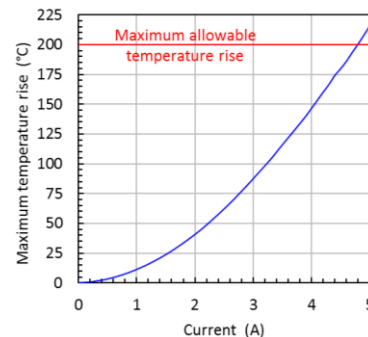
Freestanding vs. socket integrated spring probe


- Enhanced test methodology
- Socket absorbs heat, but danger of damages



Temperature rise method

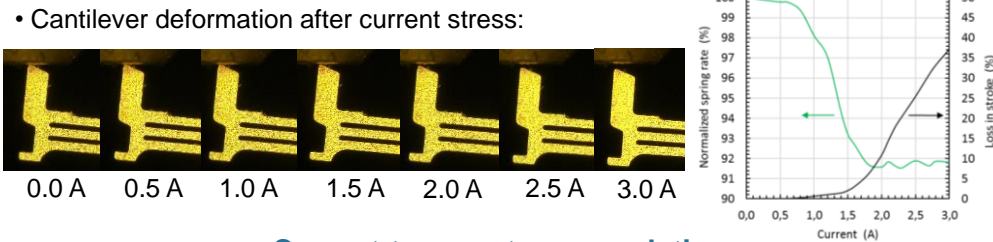
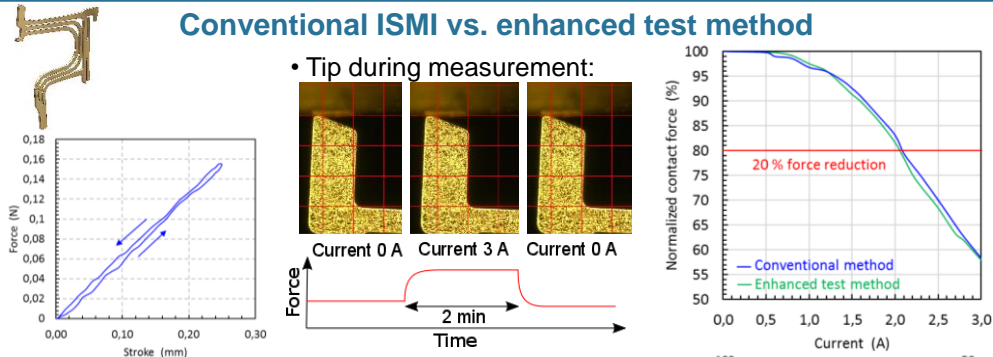
- Criterion: Rise lower than the glass transition temperature of the socket material (defined limit 200°C)
- Disadvantage: Only the surface temperature of the spring probe is measurable, not the temperature of the spring inside



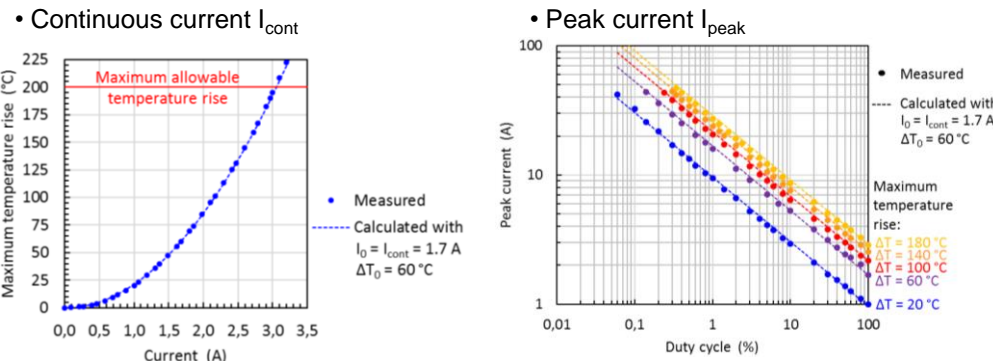
 Enhanced test method is most suitable for a freestanding spring probe

Cantilever

Conventional ISMI vs. enhanced test method



Current-temperature-correlation



• Force relaxation method fails due to loss in stroke

→ Temperature rise method is most suitable for a freestanding cantilever

• With only a single measured value ΔT_0 at I_0 all temperature rises ΔT for I_{cont}/I_{peak} can be calculated via

$$I_{cont/peak}(\Delta T) = I_0 \sqrt{\frac{\Delta T}{\Delta T_0}}$$

$$I_{peak} = \frac{I_{cont}}{\sqrt{\text{Duty cycle}}}$$

Conclusion

Measuring the CCC for different contactor types requires several approaches. These are an enhanced test method for spring probes regarding the hysteresis behavior of the contact force and the temperature rise method for cantilevers, where CCC values can be estimated by simple equations.