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D. OTIBAR

THE EFFECT OF SMA-TRAINING ON VARIATIONS OF PRODUCTION PROCESS PARAMETERS

Smart Materials & Structures, June 15-17, 2015, Las Vegas, USA

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OUTLINE

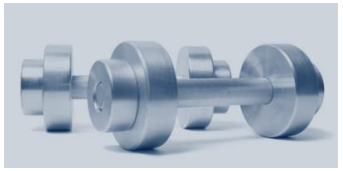
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1. Motivation
2. Standard manufacturing process
3. SMA-Training (SIMT)
4. Experimental procedure
5. Results
6. Conclusion and outlook

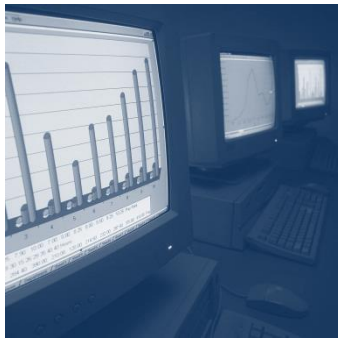
1. MOTIVATION

- Shape memory alloys (SMA) have the ability to remember a previous imprinted shape.
- SMA react sensitively to small variations in the production process.
- The reproducibility of the SMA-characteristics is subject to high demands.
- SMA-training is subsequent to the wire drawing process.
- Characteristics like displacement or actuating force can be adjusted by SMA-training.





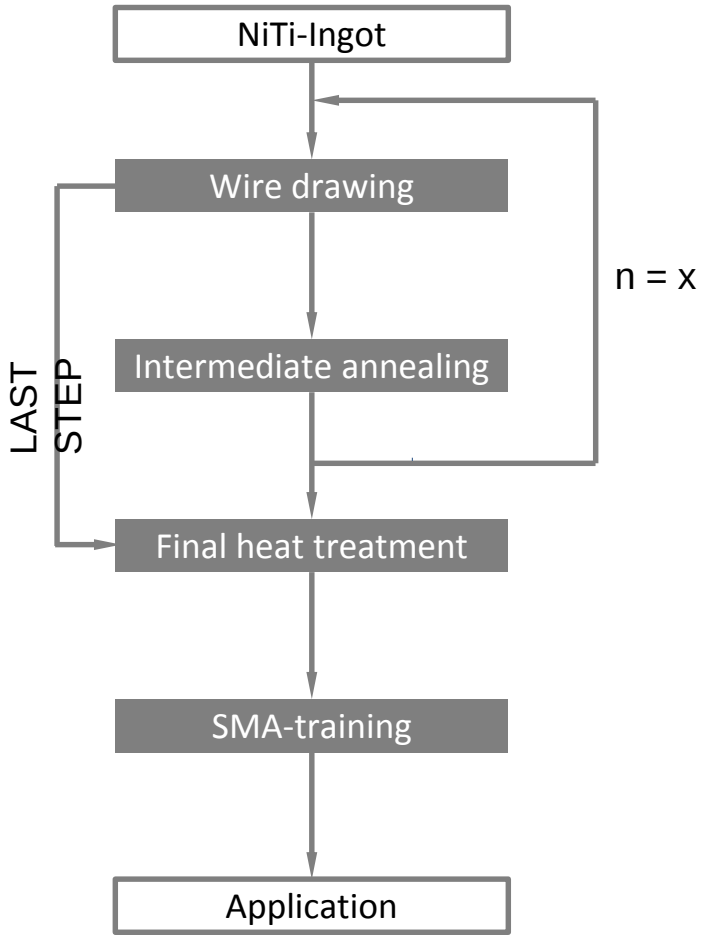




Can variations or damages caused in the production process be compensated by SMA-training?

2. STANDARD MANUFACTURING PROCESS

- The process basically consist of 4 steps.
- Wire drawing is made in different deformation
speed and rates.
- The degree of deformation is between 25% - 40%.
- Intermediate annealing is necessary to avoid material fatigue.
- A final heat treatment is made after the last drawing step.
- **These steps are followed by the SMA-training process (stress induced martensite training, …)**.

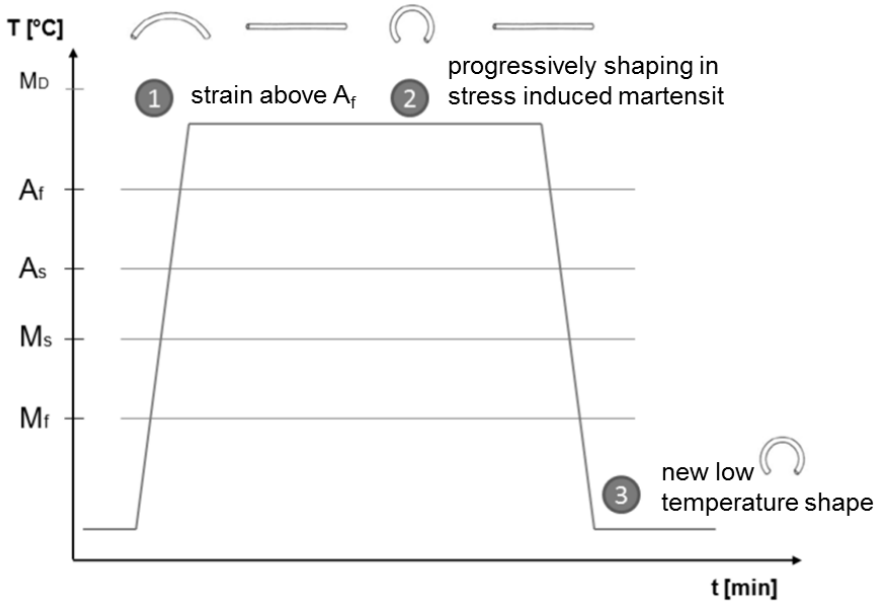


3. SMA-TRAINING (SIMT)

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SIMT → **S**tress **I**nduced **M**artensitic **T**ransformation

- SMA-device (wire) is mechanically loaded permanently
- heating up above austenite finish temperature A_f
- cooling down below martensite finish temperature M_f
- this operation is repeated up to 100 cycles



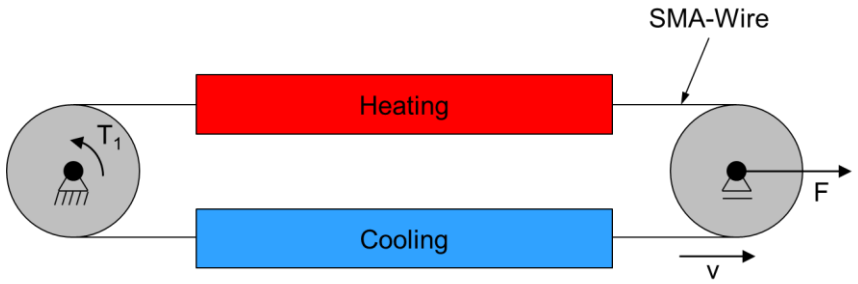
SIMT-training for minimizing running-in effects of SMA-devices

3. SMA-TRAINING (SIMT)

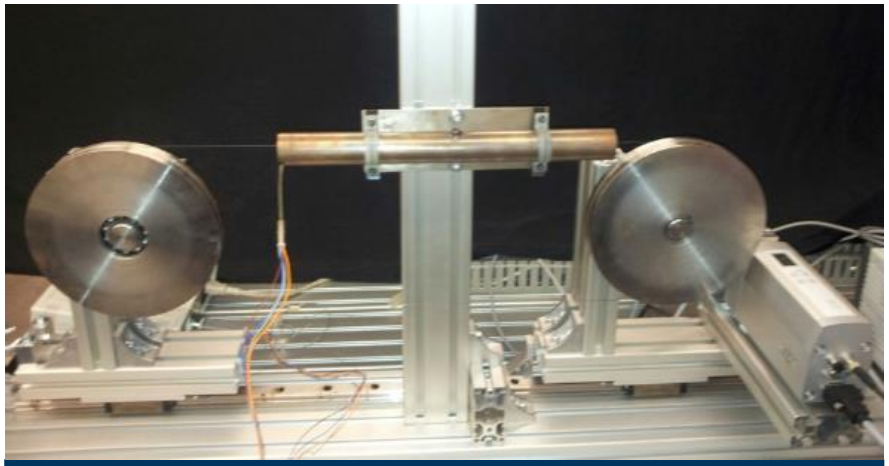
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Test rig for SMA-training

- main requirements:
  - wire diameter from 0,3 to 0,8 mm
  - heating temperature up to 400°C
  - design for stress up to 400 N/mm² (0,8 mm wire diameter)
- Test rig only for laboratory applications



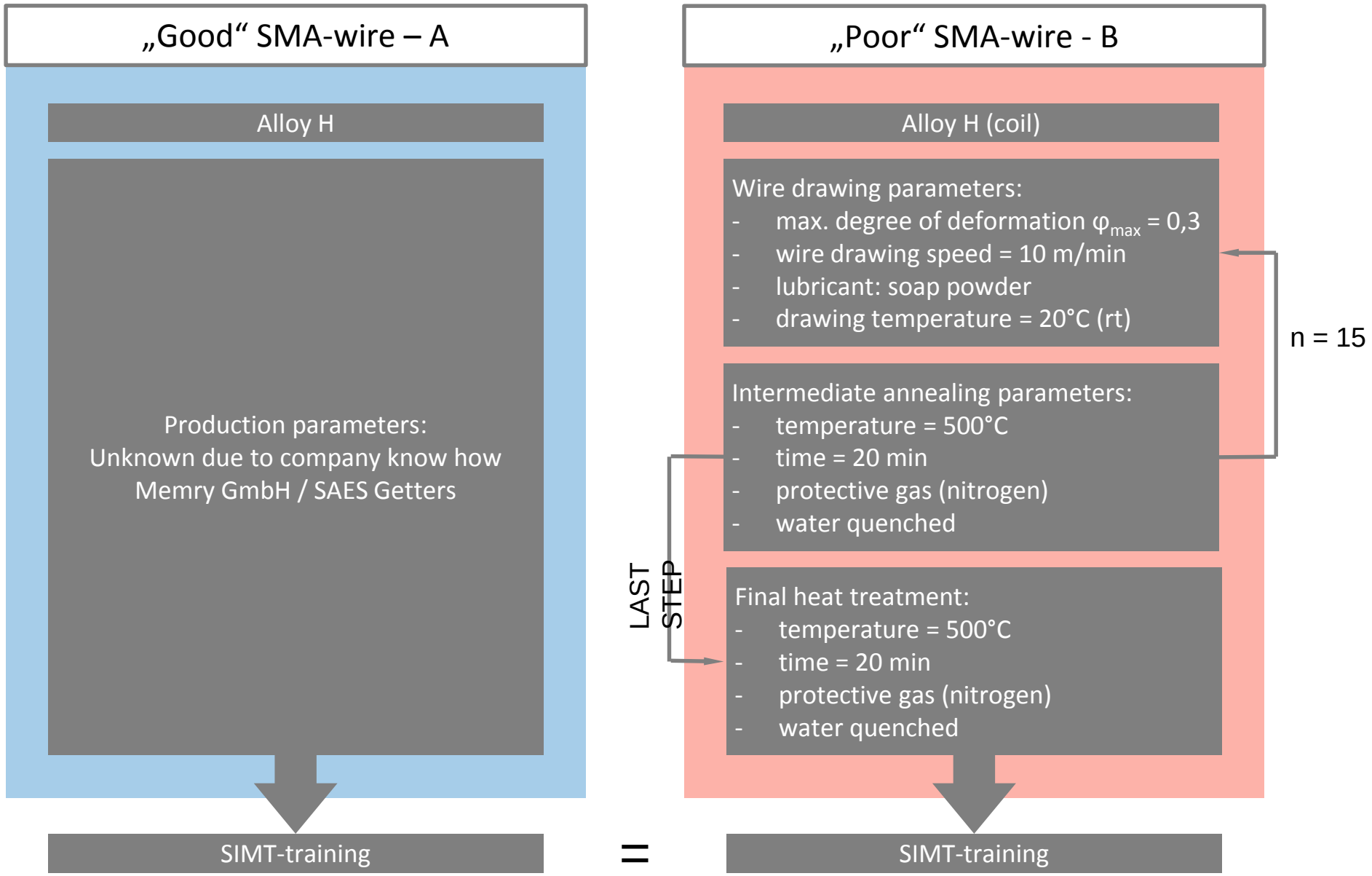
Schematic sketch of the training machine



SMA training machine

Machine for SMA SIMT training was constructed according to above mentioned requirements

4. EXPERIMENTAL PROCEDURE

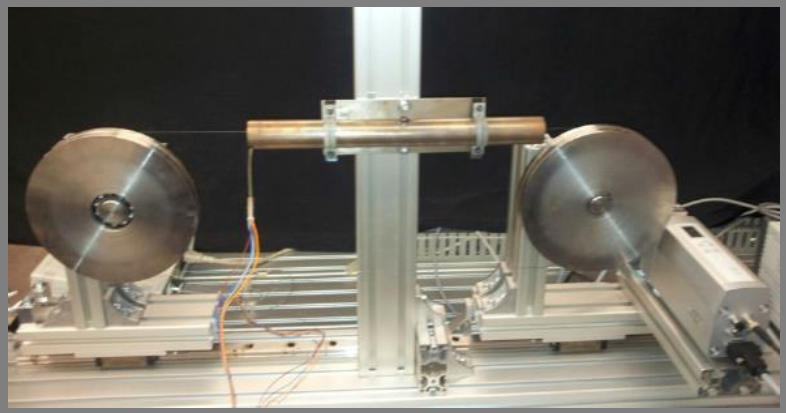


4. EXPERIMENTAL PROCEDURE

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SIMT-training parameters:

- annealing temperture = 180°C
- annealing time = 10 sec
- 80 cycles
- training stress = 175 N/mm²



Same training parameters for both wire types (A and B) are applicated

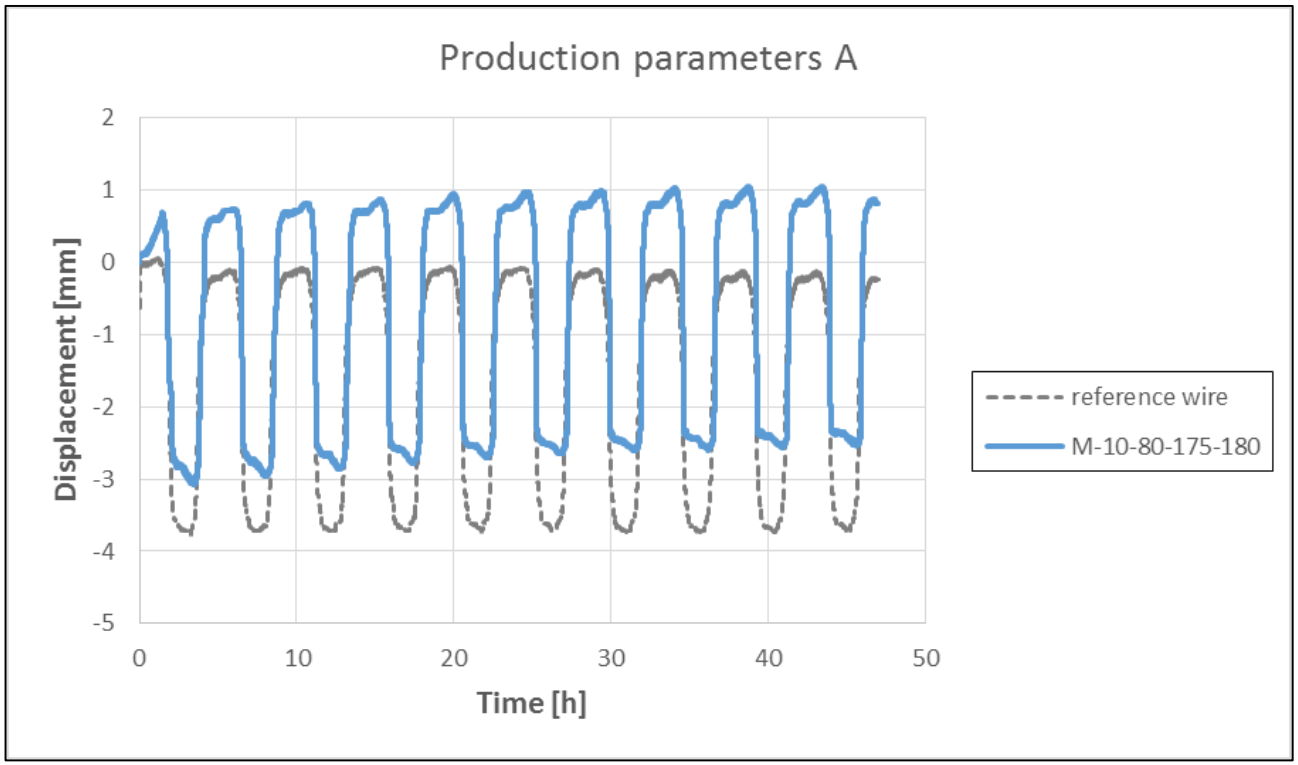
Activation tests:

- Tests are proceeded in a climatic chamber
- 10 cycles
- Temperature range from 20 to 120°C

5. RESULTS

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Results for the „good“ wire – production parameters A

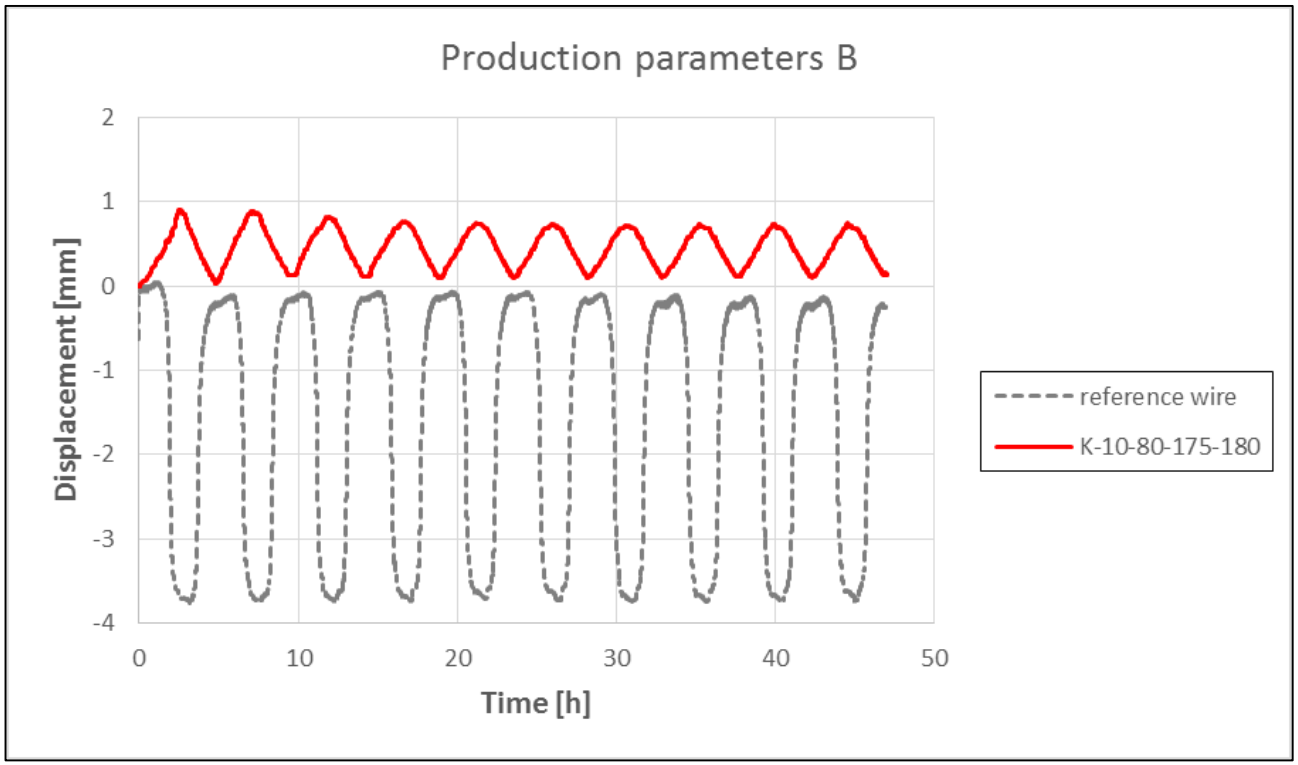


Similar characteristic to Smartflex 90 wire (high quality actuator wire) of SAES Getters

5. RESULTS

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Results for the „poor“ wire – production parameters B

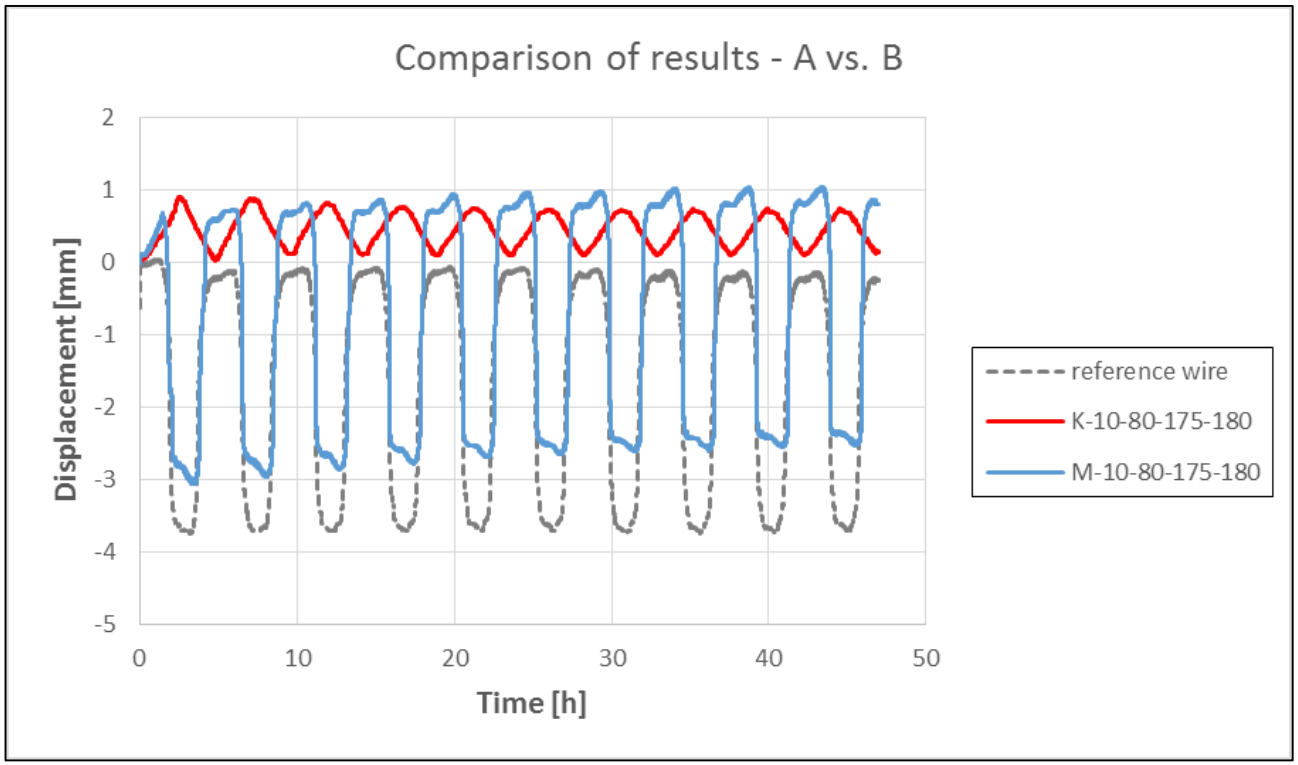


Almost no SMA effect; wire is extending when heated up!

5. RESULTS

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Comparison of the SMA-characteristics



Variations of production process parameters cannot be compensated by a subsequent SMA-training!

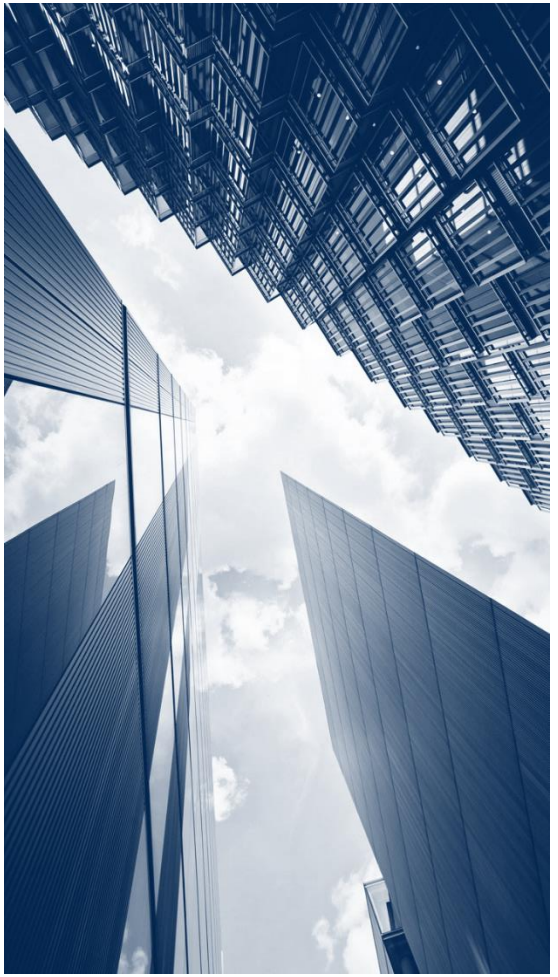
6. CONCLUSION AND OUTLOOK

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- SMA-training with same parameters was applied on wires made with different parameters.
- SMA-wires were tested to determine their SMA-characteristics.
- Despite the same training parameters, the SMA-characteristics. are strongly deviating.

Variations of production process parameters cannot be compensated by a subsequent SMA-training!

- In further studies, the effect of SMA-training on only slight variations in the production process can be investigated.
- Different training parameters can be tested.
- Different training methods can be analyzed.





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Thank You!
D. Otibar