



Institut für
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Quinary and Senary High Entropy Shape Memory Alloys

Part II: Extrusion, Functionality, Degradation

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Project: New Quinary and Senary High Entropy Shape Memory Alloys (HE-SMA) – Exploring and Exploiting Martensitic Transformations and Shape Memory Effects in Chemically Complex Systems

Projectduration: 3 years

Applicants/PI: G. Eggeler (Ruhr-Universität Bochum)
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H. J. Maier (Leibniz Universität Hannover)



M.Sc. Oluwaseyi Oluwabi

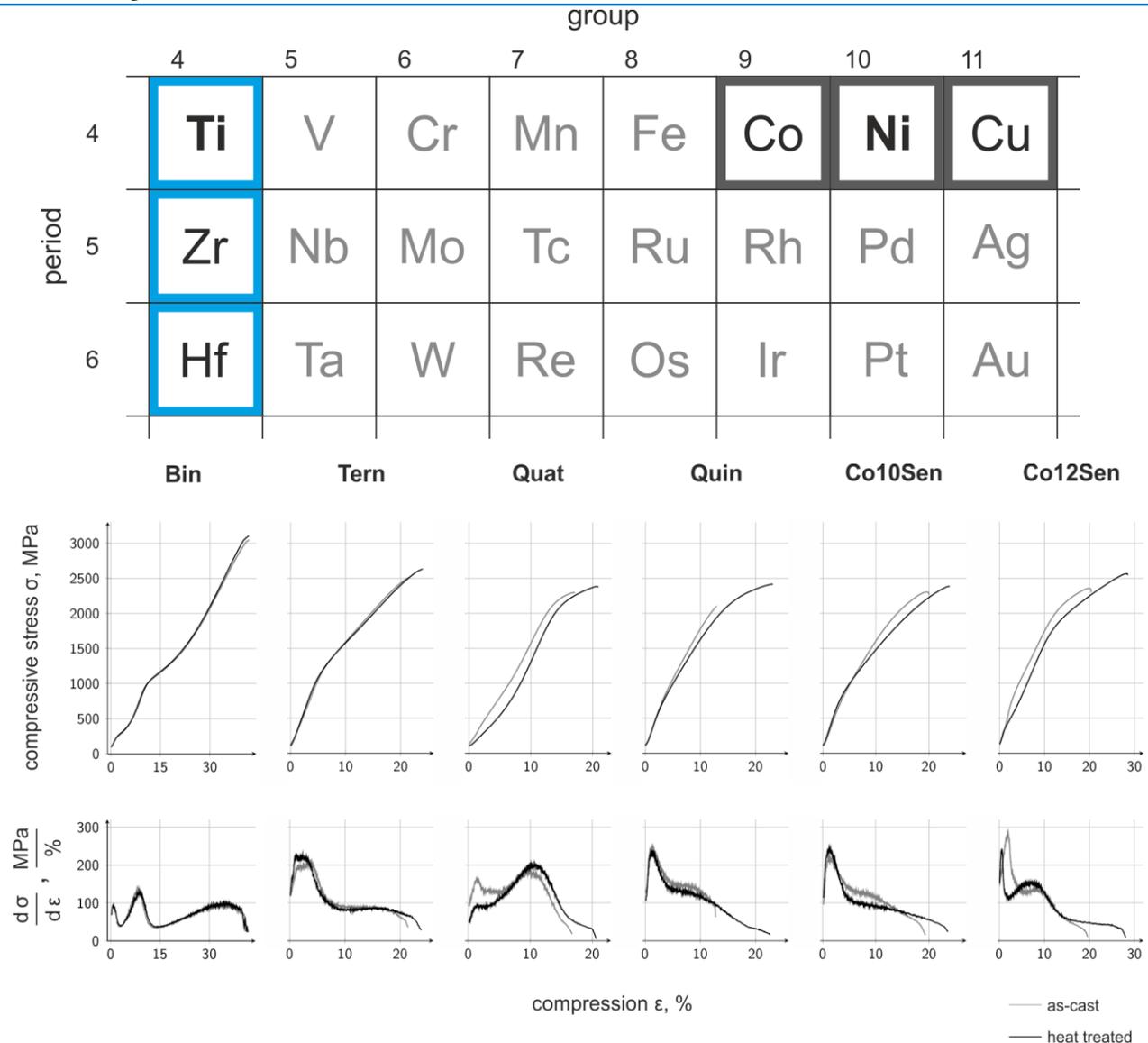


M.Sc. Christian Hinte



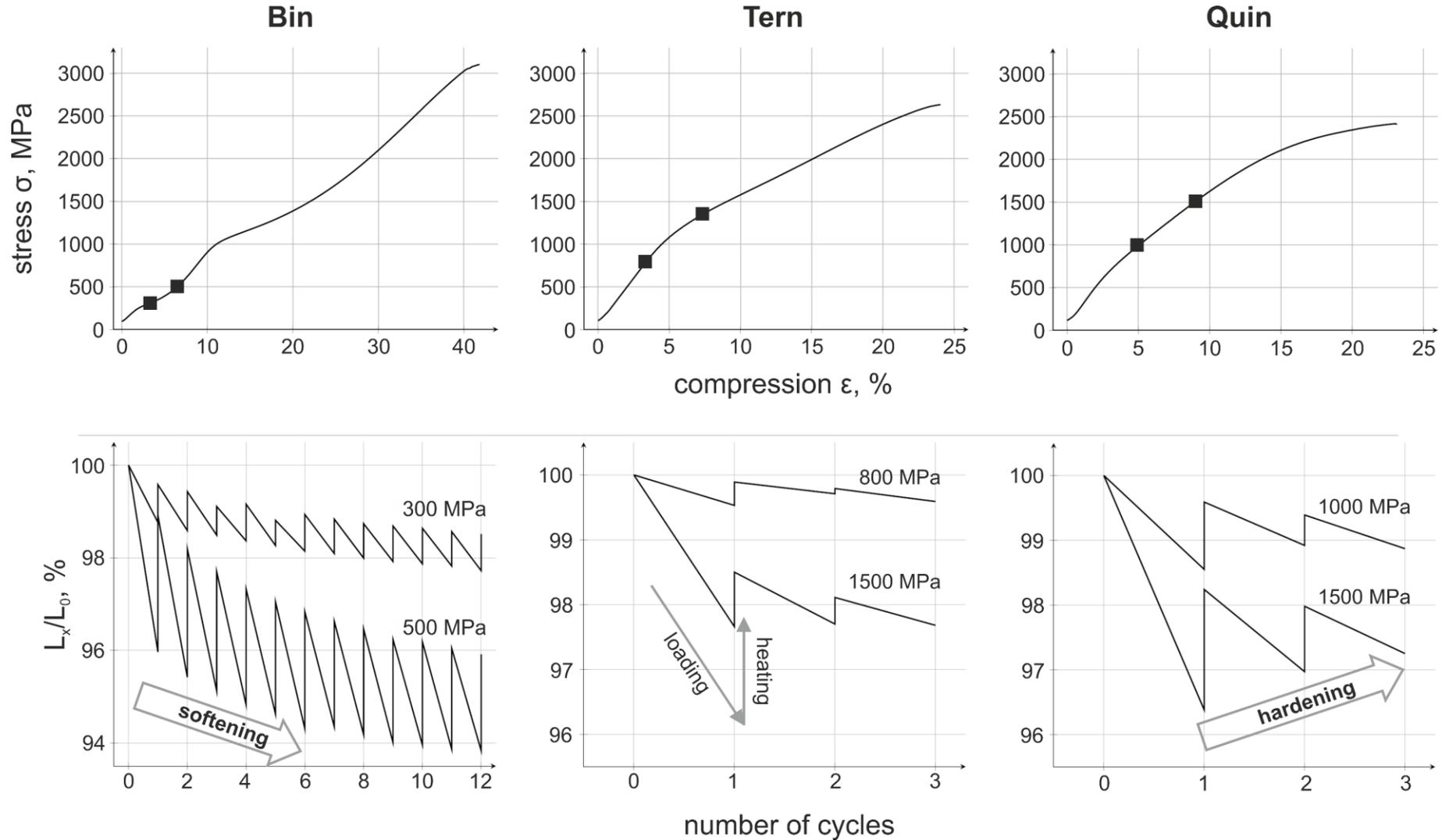
First period - mechanical properties binary to senary

- increasing chemical complexity (NiTi – TiZrHfCoNiCu(Pd))
- results in decrease of ultimate compression strength
- influence of heat-treatment increases with number of elements
- test temperature defines material behavior of shape memory alloys (austenite <-> martensite)

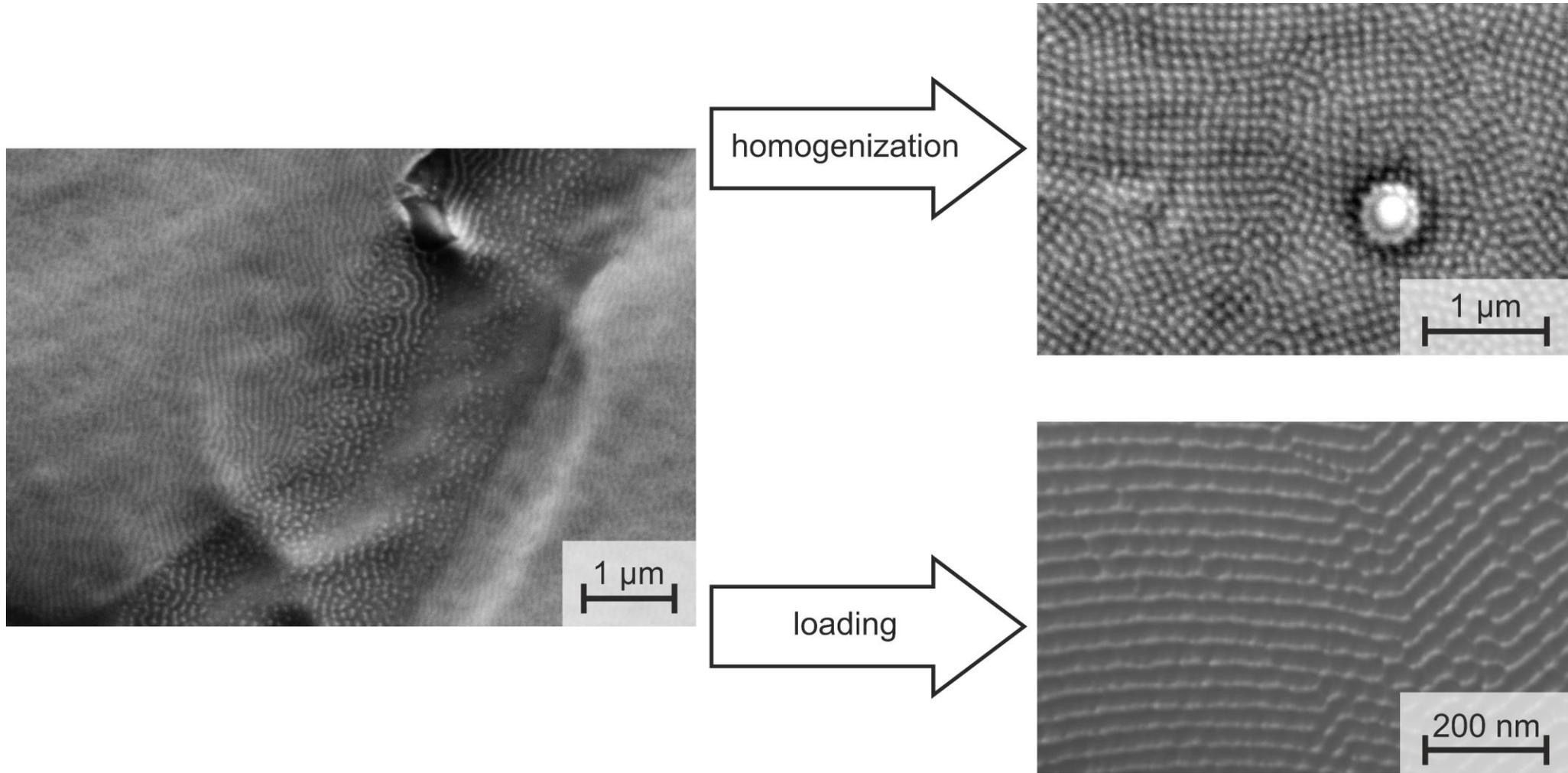


(Hinte et al., Shape Mem and Superelasticity, 2020)

First period – functional properties/ shape recovery



(Hinte et al., Shape Mem and Superelasticity, 2020)



(Hinte et al., Scripta Mater, 2020)

Motivation second period

first period

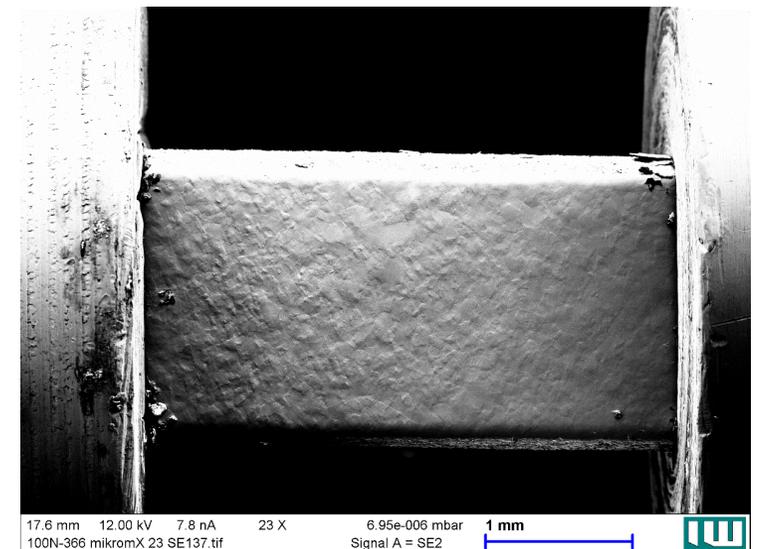
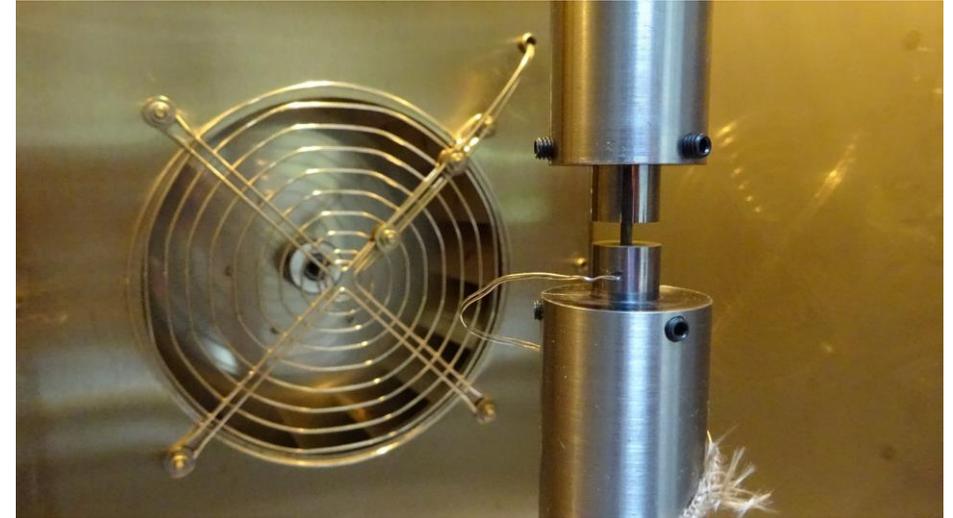
- NiTi-related high entropy shape memory alloys (HE-SMAs) as a promising alloy system
- Recovery after high stresses
- High functional and structural fatigue limits the applicability of shape memory alloys



second period

- Investigating new NiTi-related HE-SMAs
- Characterization of the fatigue behavior of HE-SMAs
- Demonstrator setup and functional performance

- **mechanical characterization**
- **functional testing**
 - stress-induced martensite
 - detwinning behavior
 - pseudoelastic regime
 - shape recovery
- **functional fatigue**
 - damping
 - actuation



➔ **identification of degradation mechanisms**

Second period - thermoforming

- brittle, high strength material

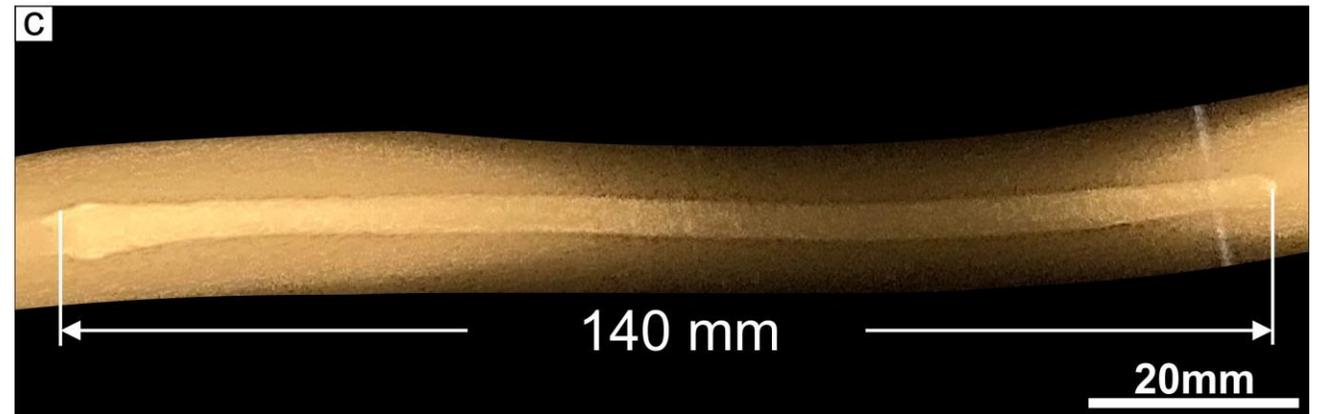
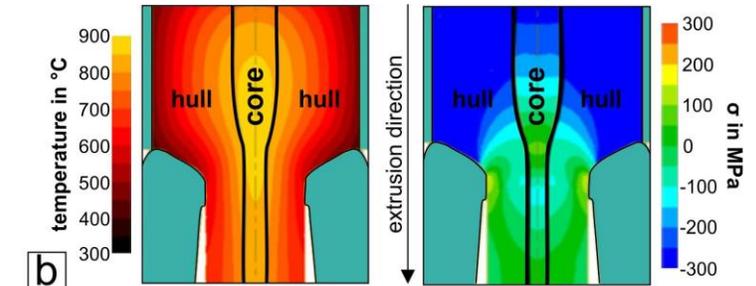
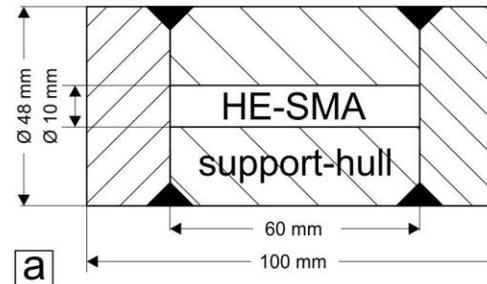
Hot-forming:

- hull-supported-forming
- high temperature & deformation

- increase in homogeneity and grain sizes
- improving material quality for wire drawing

Cryo-forming:

- high maximum compression at cryo temperatures

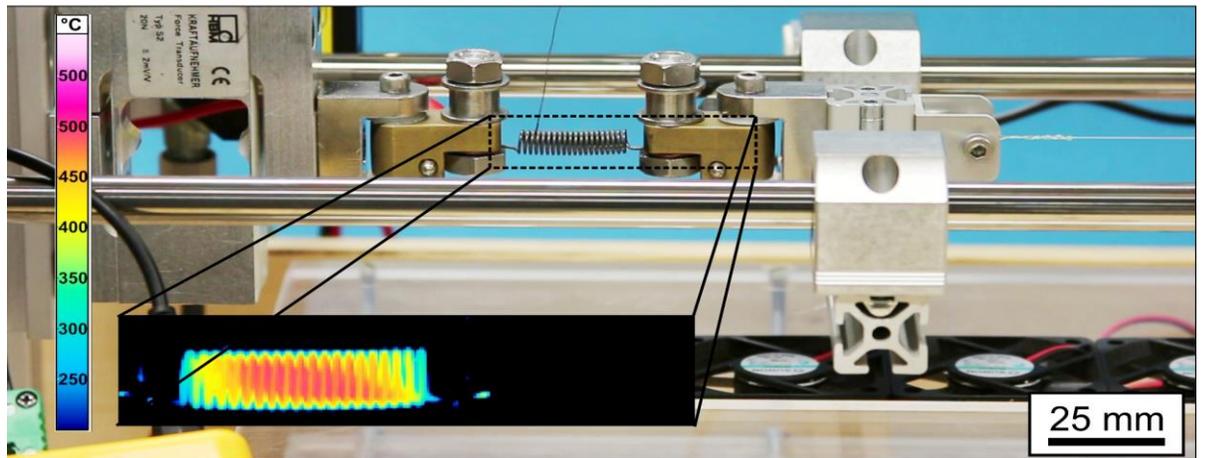
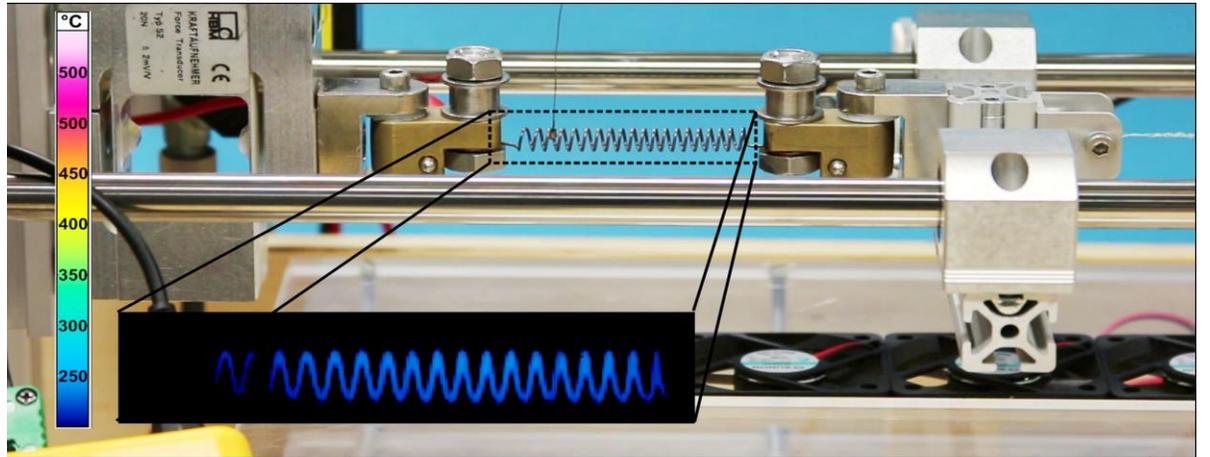


Wire Drawing/ Spring Actuator

- wire drawing in Bochum
- spring forming in Hannover

Demonstrator setup:

- material state
- annealing temperature
- test temperature & load



- New quinary and senary NiTi-related high entropy shape memory alloys
- Mechanical and functional testing
- Identification of degradation mechanisms
- Thermoforming for wire drawing
- Actuator setup

