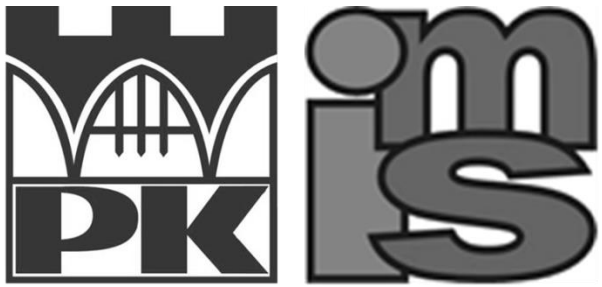
Experimental set-up for strength test at cryogenic temperature

Jakub Tabin, Błażej Skoczeń



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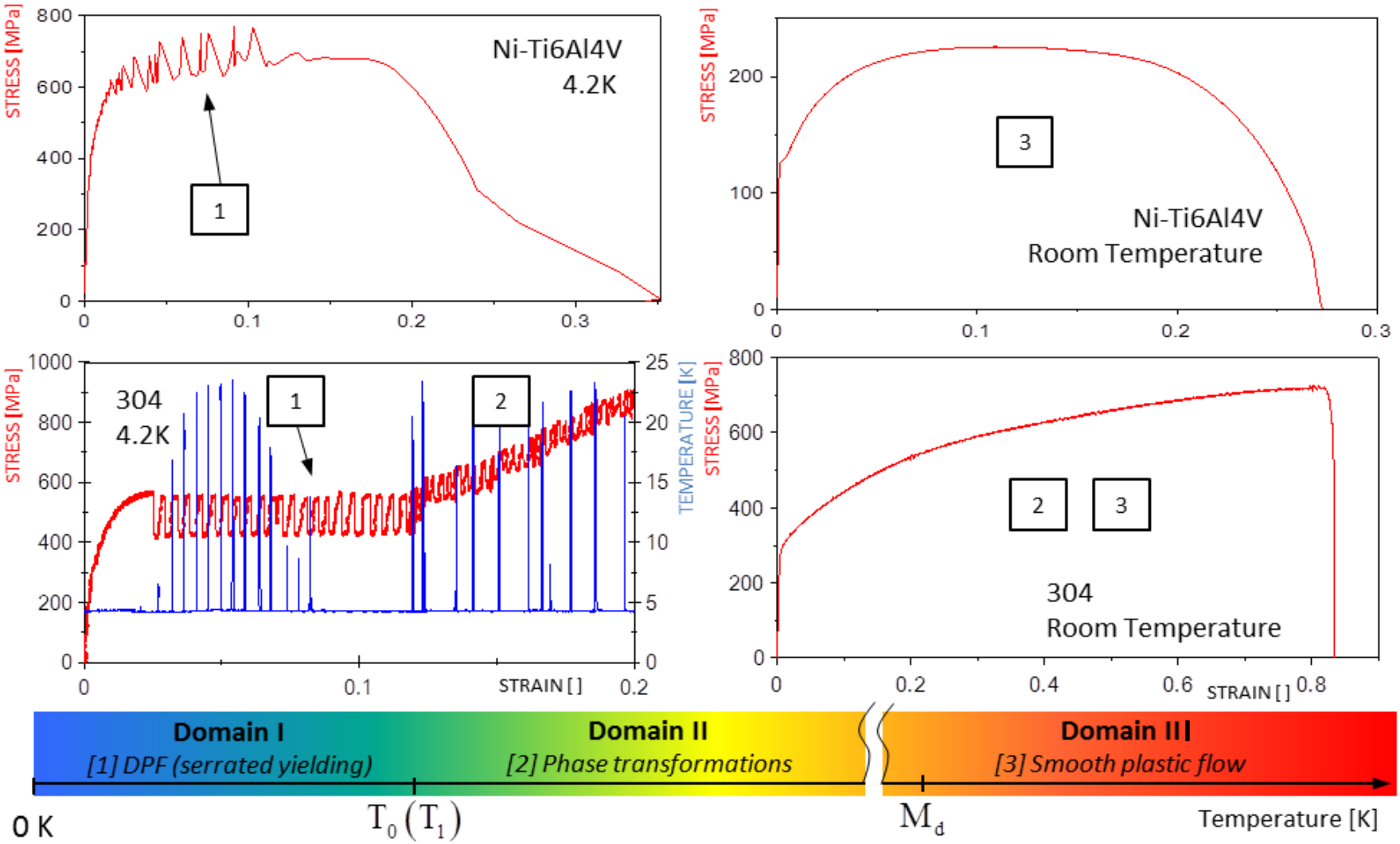
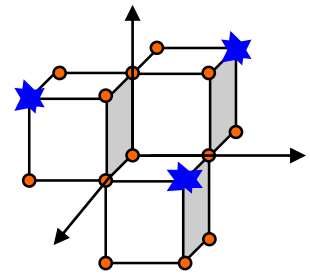
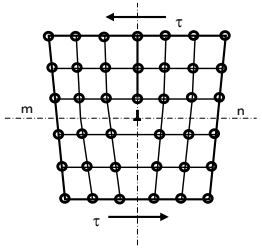
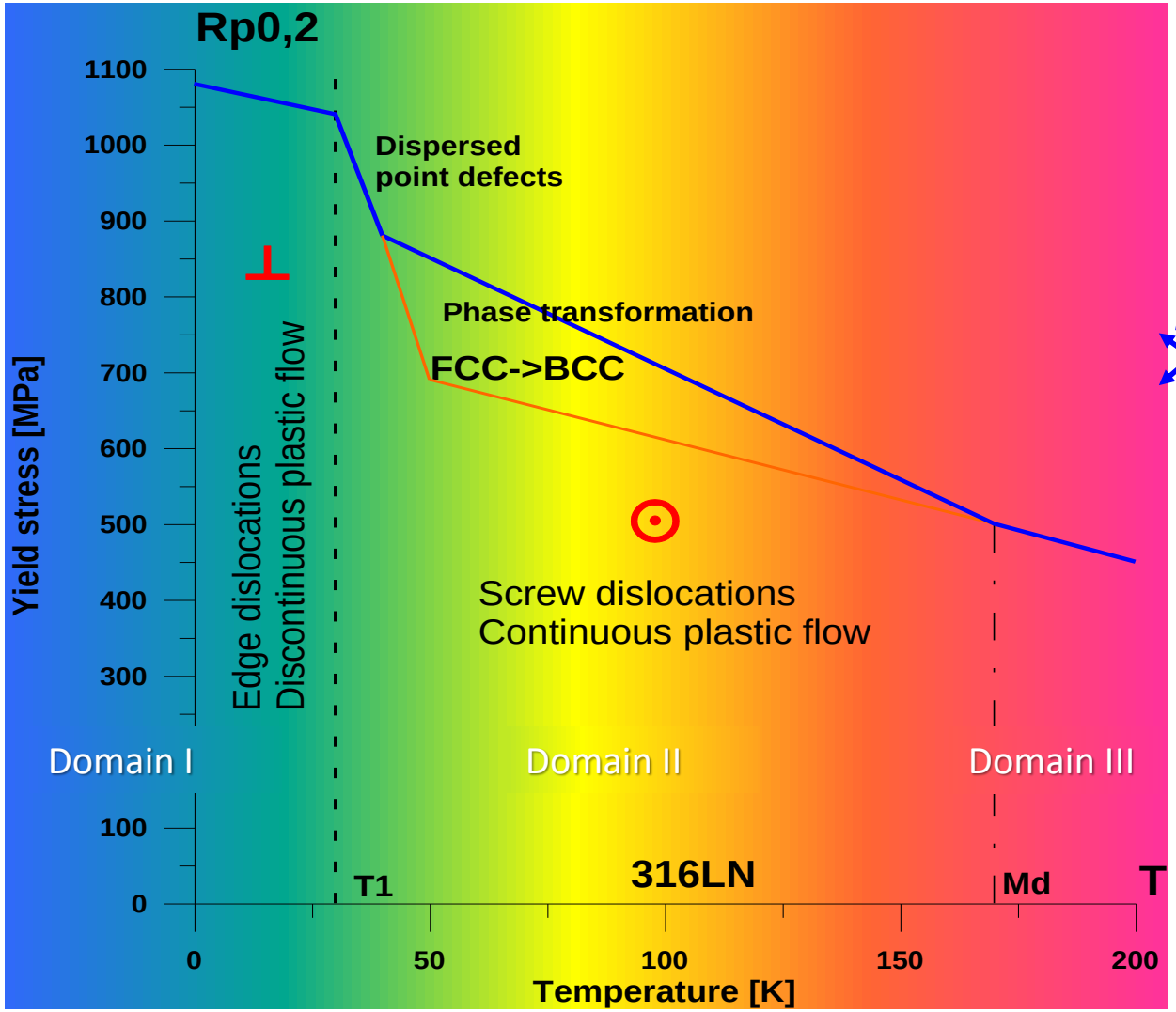
Strain induced phenomena as a function of temperature

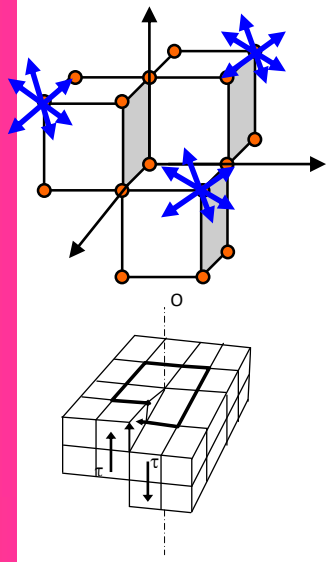


Mechanisms of plastic flow at cryogenic temperatures









Done and to be done…

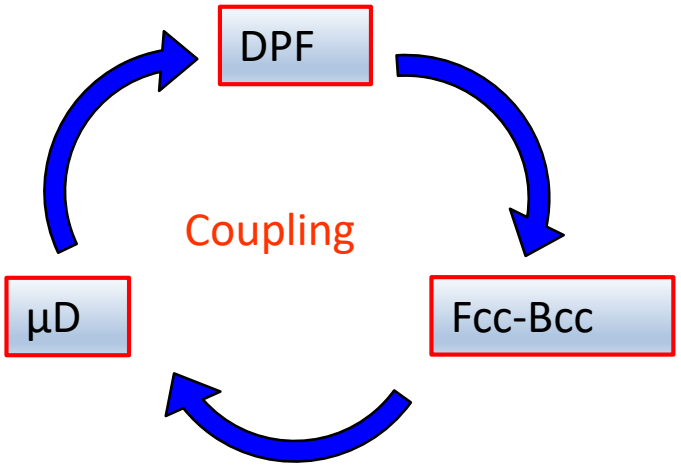
I stage: constitutive models of single phenomena

Strain induced phenomena at extremely low temperatures

Done

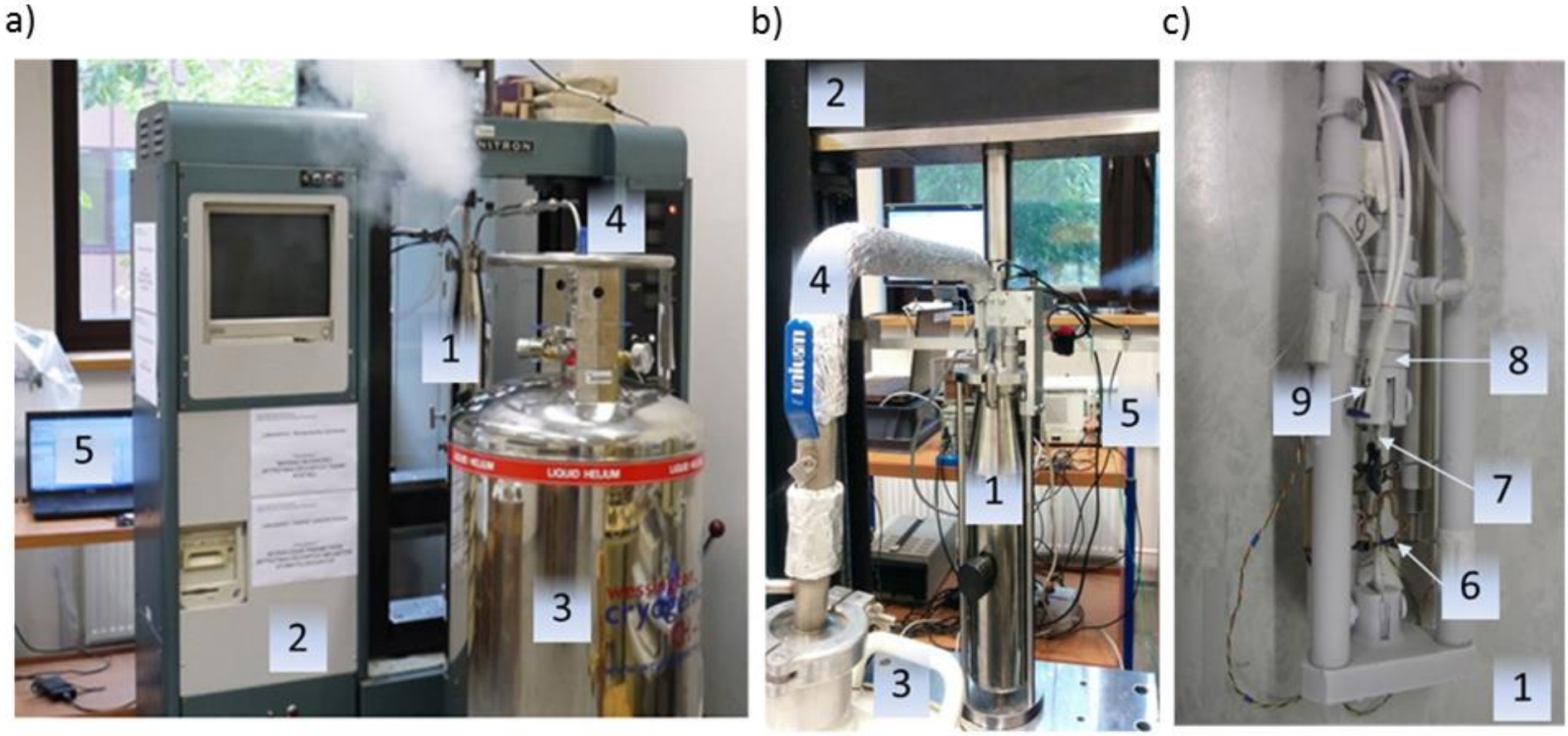
- Discontinuous plastic flow DPF
- Plastic strain induced Fcc-Bcc phase transformation
- Nucleation and evolution of micro-damage μD

II stage: coupling between the phenomena



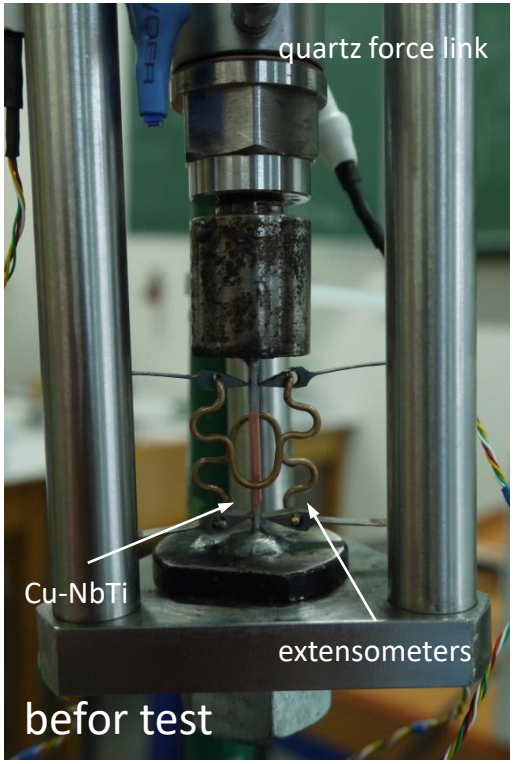
In progress

Experimental set-up



Experimental set-up for: a) uniaxial tensile tests; b) combined loading; c) cryostat with equipment
(1- cryostat, 2- tensile test machine, 3- cryogen dewar, 4- cryogen transfer line, 5- DAQ system, 6- clip-on extensometers, 7- specimen, 8- force transducer, 9- thermistor)

Experimental set-up…



Experimental results

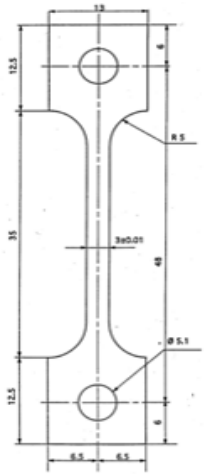
CERN

TS/MME/MM

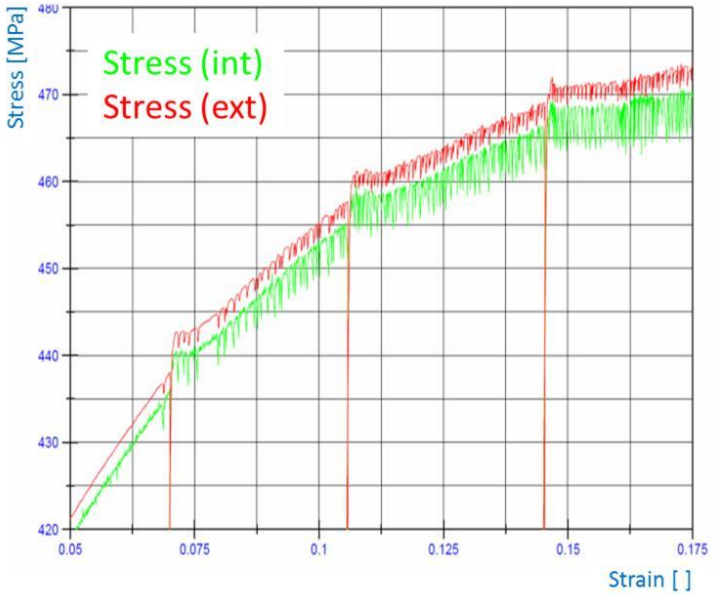
TEST REPORT

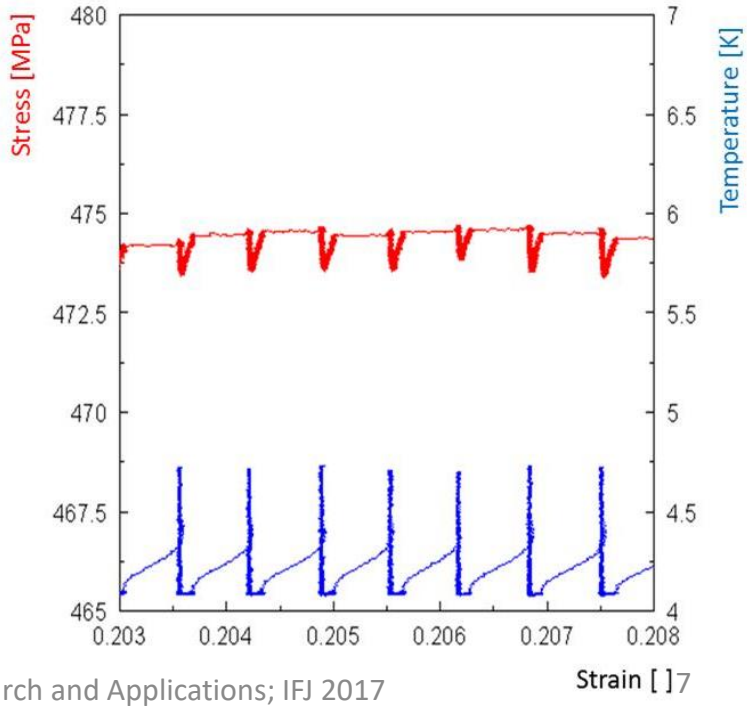
Test Data	
Test Number	
Material	Cu OFE
Testing Temperature (K)	4.2
Samples	sample 5
Width (mm)	
Thickness (mm)	
Section (mm^2)	9.06
Extensometer gauge length Le (mm)	17.5
Final gauge length Lu (mm)	25.2
Elongation after fracture A (%)	44
Young modulus (GPa)	137
Tensile strength Rm (MPa)	
Proof strength Rp0.2 (MPa)	324
Stroke speed (mm/min)	1.5
Sampling frequency (Hz)	
Tensile Test machine	
Remarks	

Sample drawing



Tests carried out by Dawid Marcinrk





Experimental results

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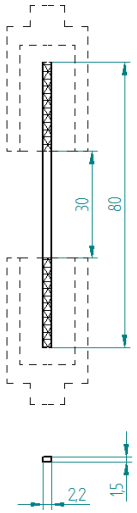
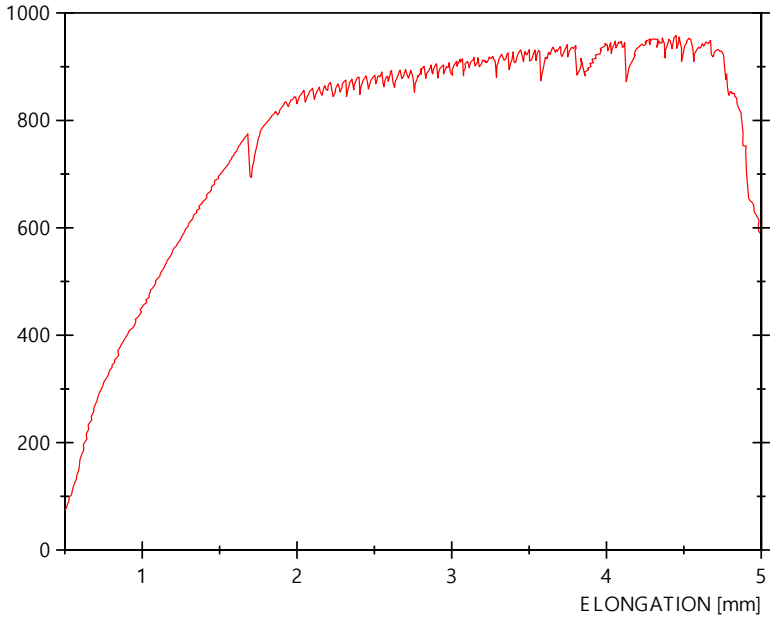
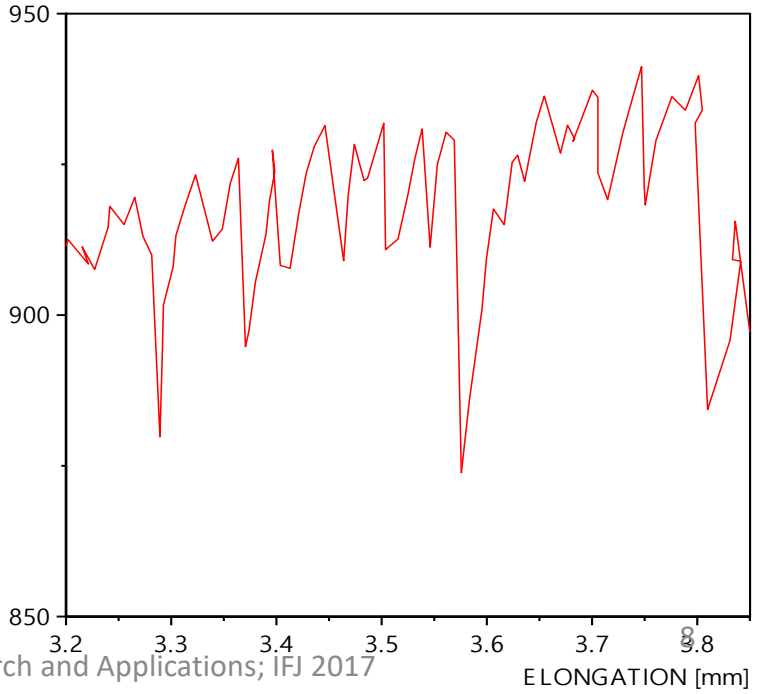
TEST REPORT

Test Data	
Test Number	13
Material	Cu/Ni-Ti
Testing Temperature (K)	4.2
Samples	sample 2
Width (mm)	2.2
Thickness (mm)	1.50
Section (mm^2)	3.30
Extensometer gauge length Le (mm)	20.0
Final gauge length Lu (mm)	20
Elongation after fracture A (%)	x
Young modulus (GPa)	x
Tensile strength Rm (MPa)	x
Proof strength Rp0.2 (MPa)	x
Stroke speed (mm/min)	0.5
Sampling frequency (Hz)	
Tensile Test machine	INSTRON TT

Sample drawing







Experimental results

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TEST REPORT

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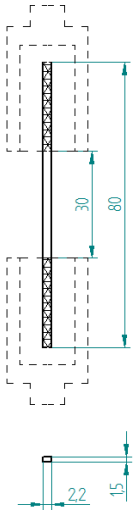
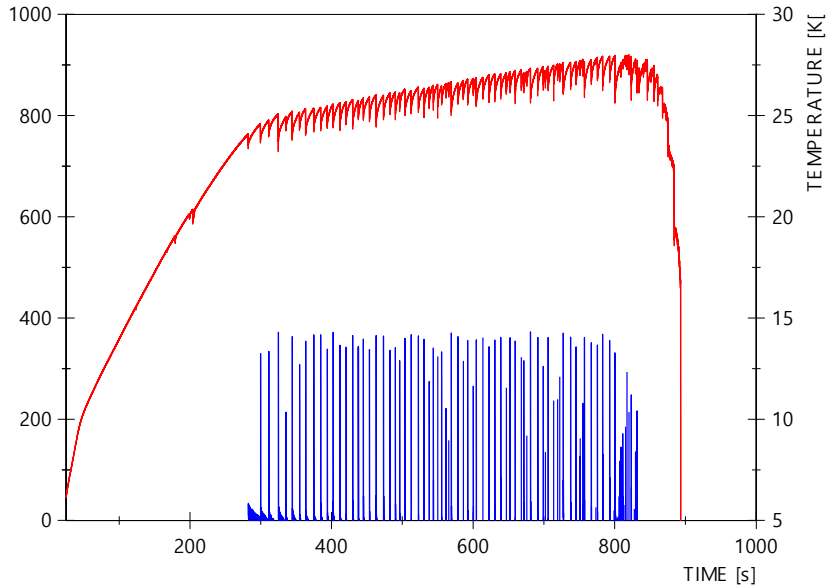
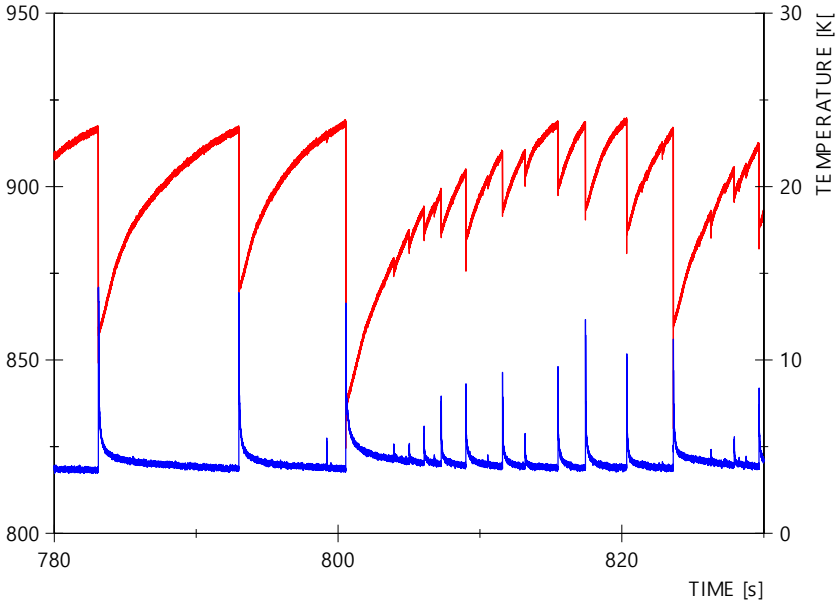
Section (mm^2)	3.30
Extensometer gauge length Le (mm)	20.0
Final gauge length Lu (mm)	20
Elongation after fracture A (%)	x
Young modulus (GPa)	x
Tensile strength Rm (MPa)	x
Proof strength Rp0.2 (MPa)	x
Stroke speed (mm/min)	0.5
Sampling frequency (Hz)	1000
Tensile Test machine	INSTRON TT

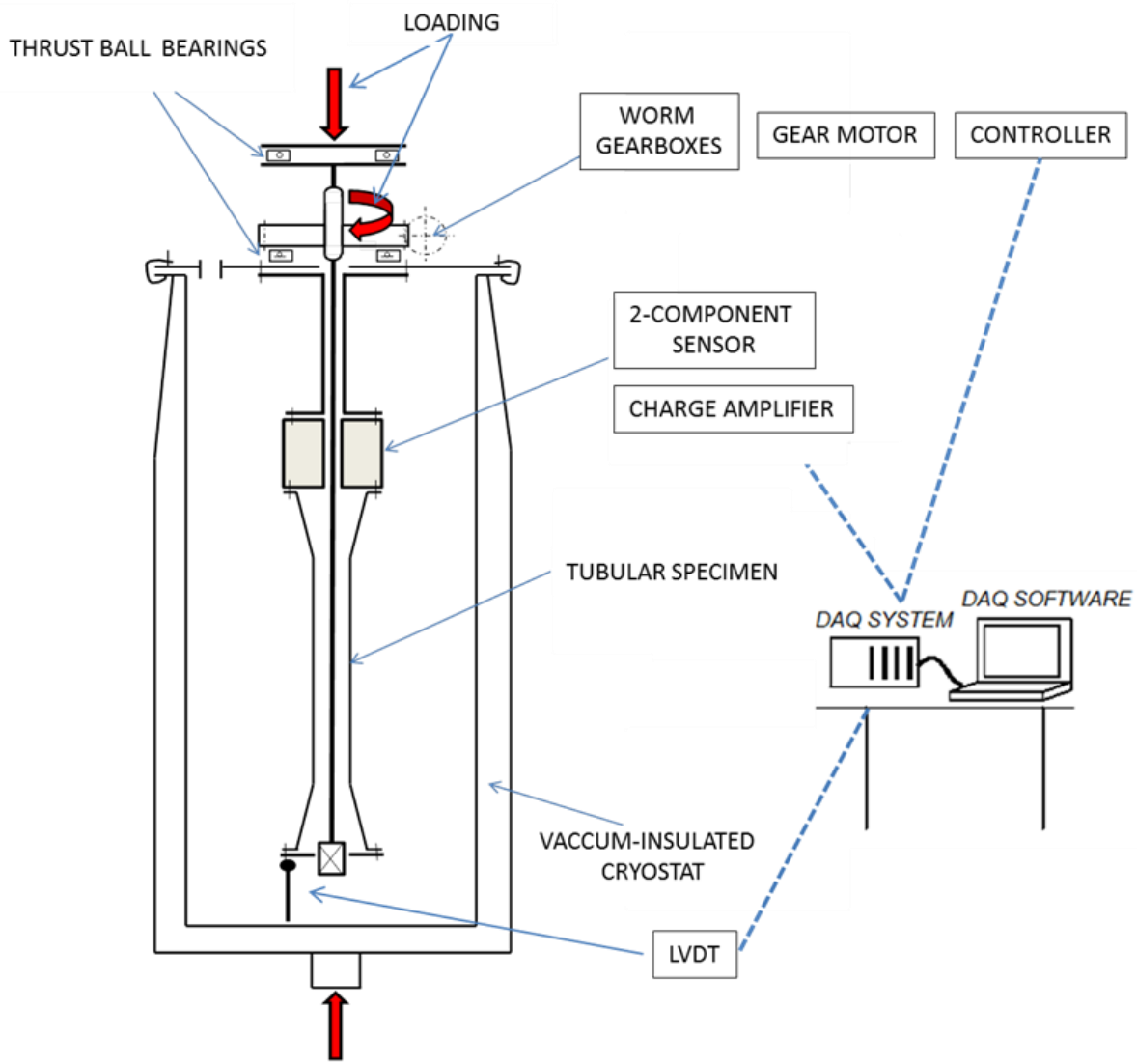
Sample drawing

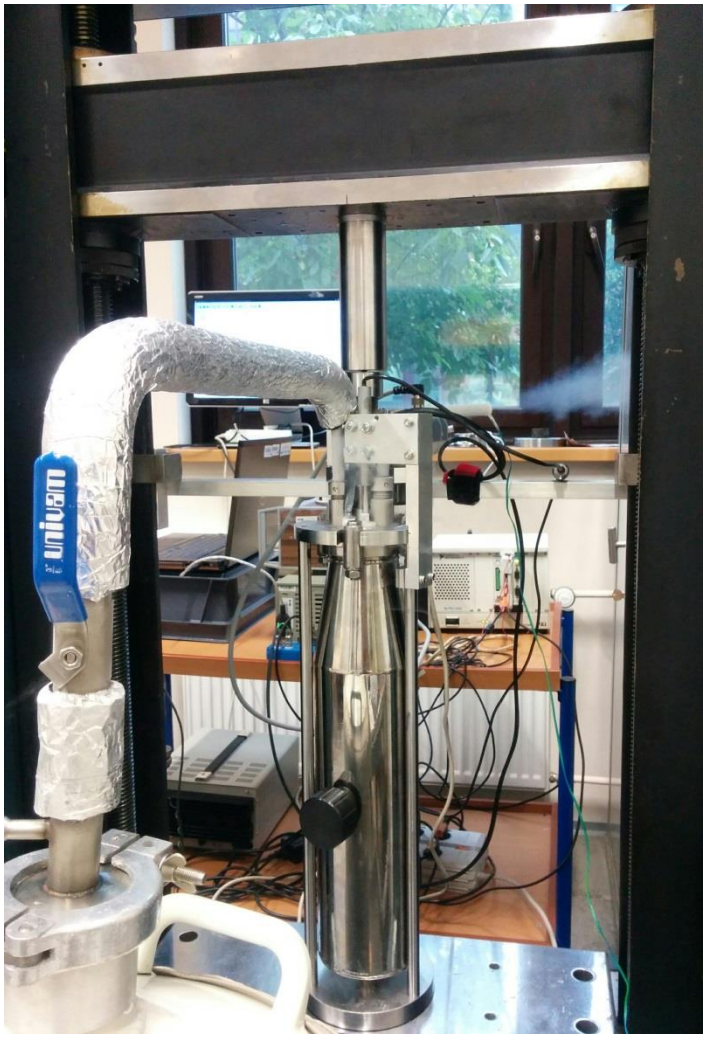




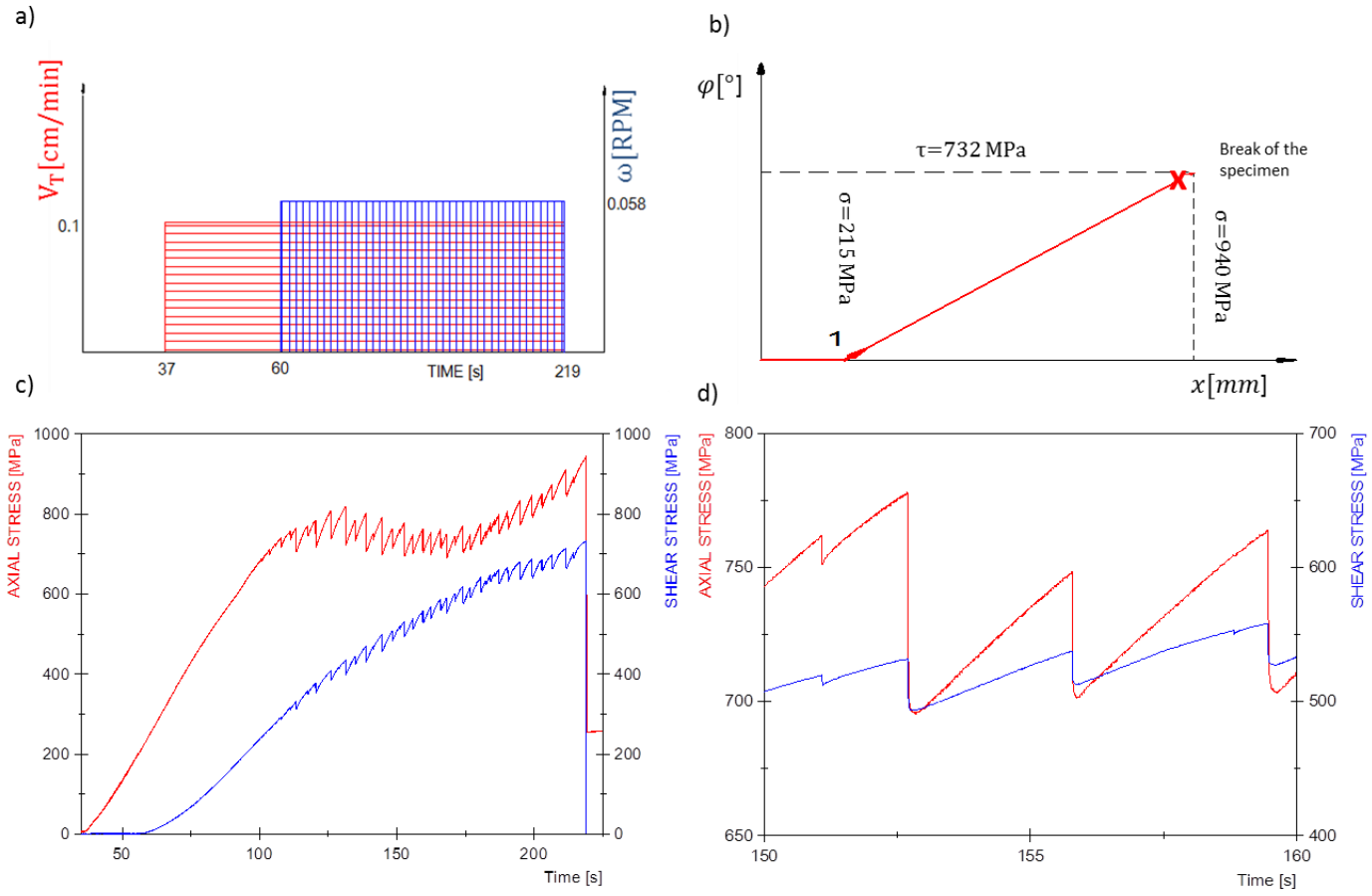


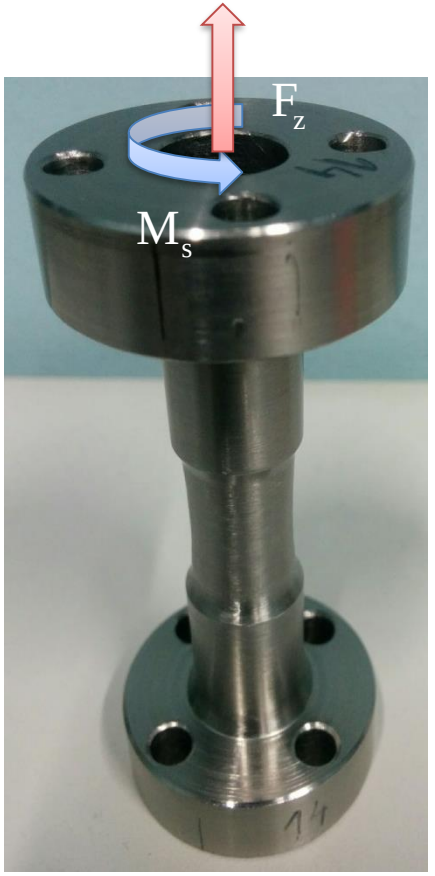
Experimental set-up for combined loading





Experimental results





DPF in the multiaxial regime: a) kinematically controlled combined loads; b) loading path; c); d) test results: combined torsion (red curve) and traction (blue curve) for 304ss

Conclusion

1. Przeprowadzenie testów wytrzymałościowych:
    a. obciążenie jednoosiowe
    b. obciążenie złożone, ścieżki nieproporcjonalne
2. Identyfikacja doświadczalna dysypatywnych zjawisk sprzężonych w materiałach polikrystalicznych, kompozytowych w kriogenicznym zakresie temperatury:
    a. DPF
    b. przemiana RSC-RPC
    c. ewolucja mikrouszkodzeń

Future work

1. Analiza zjawiska DPF ora efektu „stick-slip” w próbkach wykonanych z kompozytu nadprzewodnikowego zawierającego jednokierunkowe włókna (np. Cu/NbTi, Cu/Nb3Sn)
2. Analiza propagacji mikroszczeliny w materiałach heterogenicznych w kriogenicznym zakresie temperatury
3. Rozbudowa stanowiska do analizy mikrostruktury o moduł EBSD, ferrytoskop
4. Rozbudowa stanowiska do testów wytrzymałościowych o układ do pomiaru emisji akustycznej