Peculiarities of deformation of CoCrFeMnNi at very low temperature

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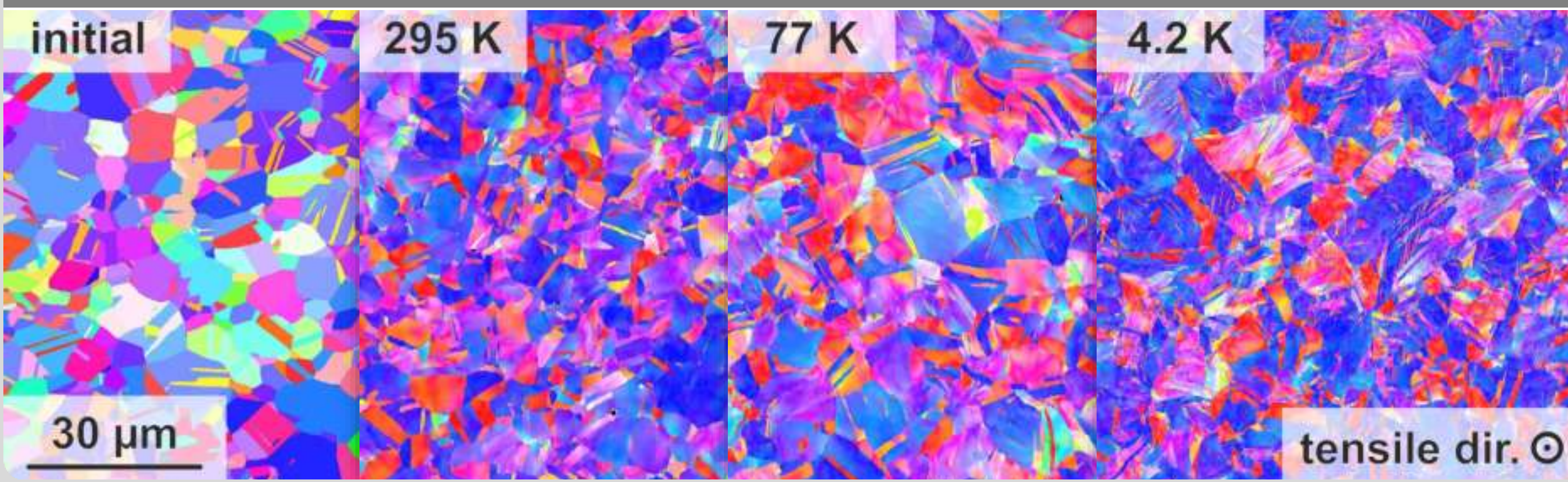
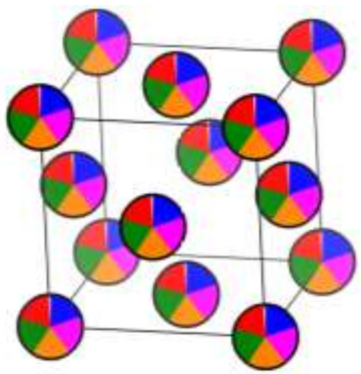
A contribution to the **'HEA branch'** of the SPP

Institute for Applied Materials (IAM-WK) and Institute for Technical Physics (ITEP)

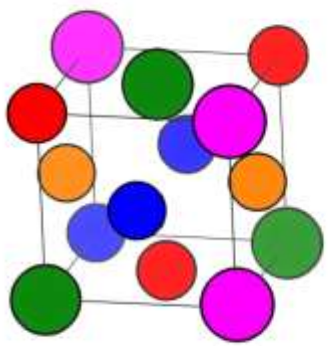


Motivation and Background

Low Temperature Deformation of CoCrFeMnNi



vs.

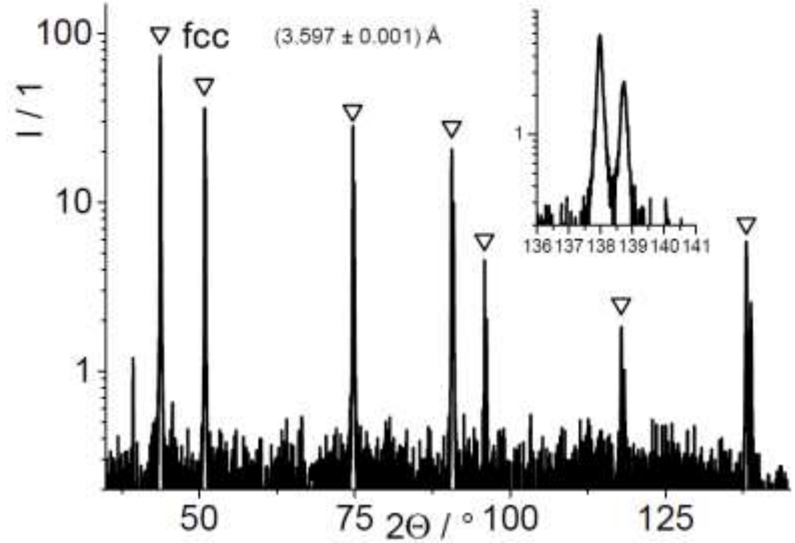


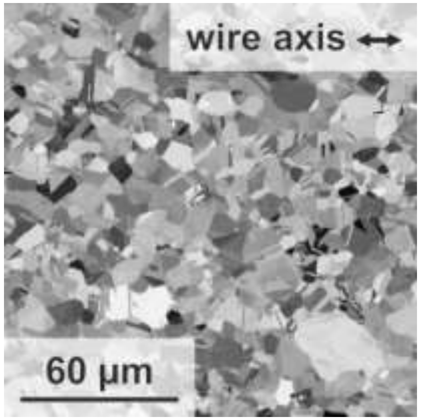
- Peculiarities in the low temperature deformation of CoCrFeMnNi
- Impact of lattice distortion on the movement of dislocation
- Interaction of dislocations and solutes or local chemical order

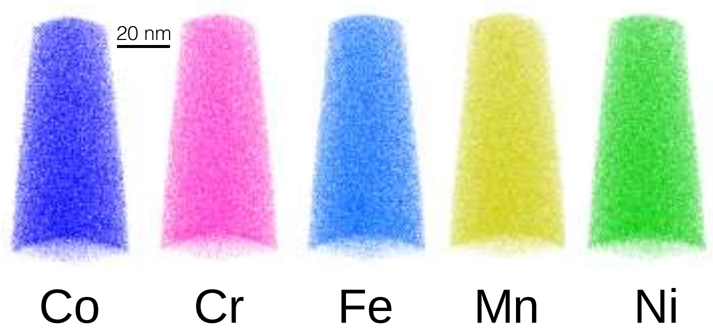
Manufacturing of CoCrFeMnNi

for reproducible materials testing and characterization

- Manufacturing:
  - arc-melting
  - homogenization (1200 °C, 72 h)
  - rotary swaging (φ = 1.39)
  - static recrystallization (800 °C, 1 h)
- Reproducibility
  - nominal composition (ICP-OES)
  - solid solution formation (APT + XRD)
  - recrystallization of entire microstructure (ECCI)





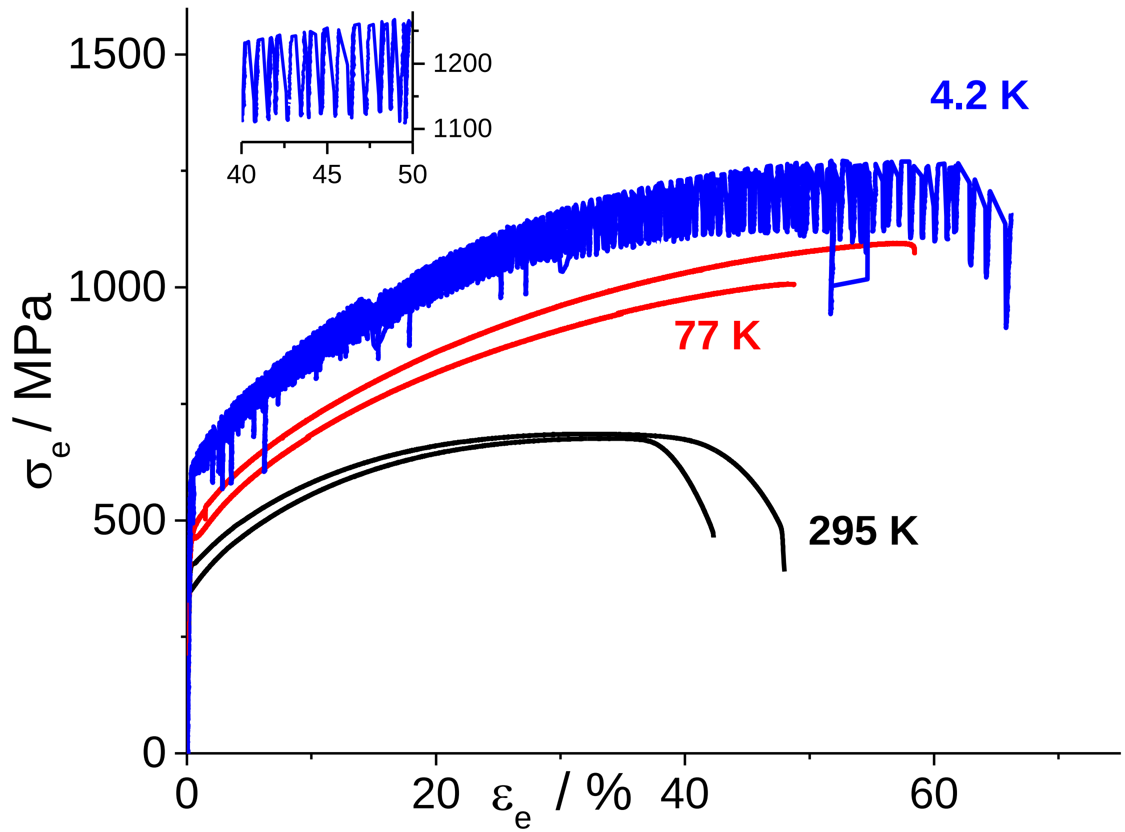


APT in collaboration with Dr. J.N. Wagner

Deformation behavior of CoCrFeMnNi

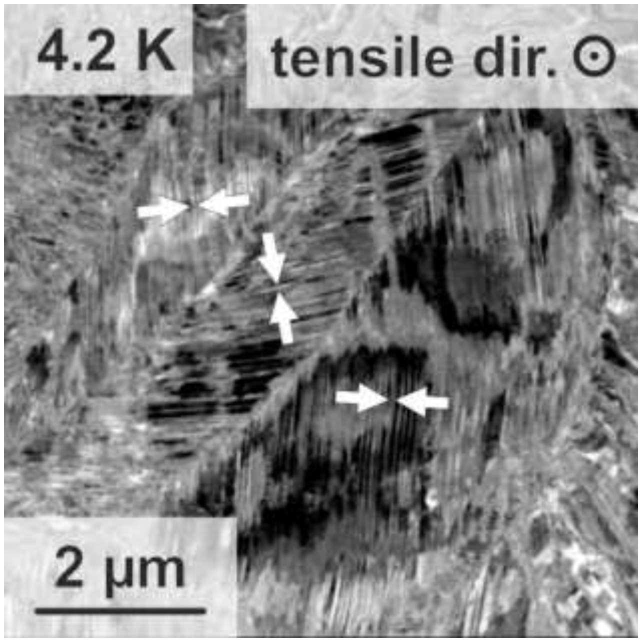
at very low temperatures

- Increasing yield strength as well as ductility when lowering temperature
- **High work-hardening**
- **Deformation appears serrated at 4.2 K**

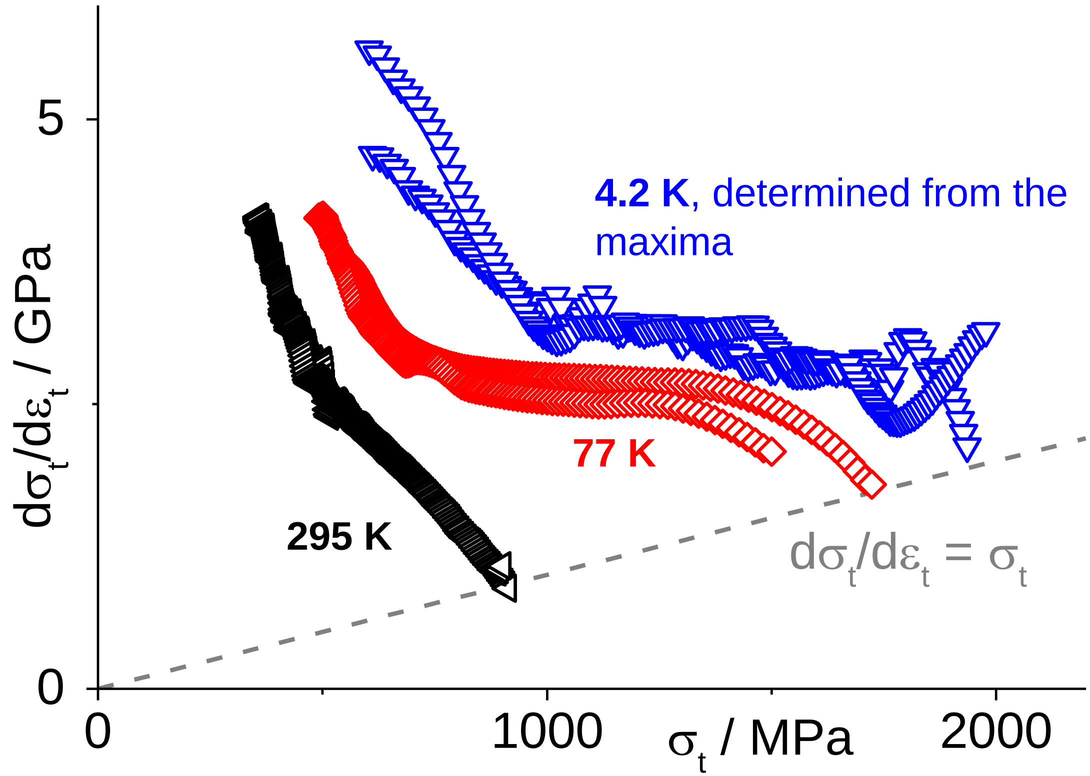


Work-hardening

at very low temperatures

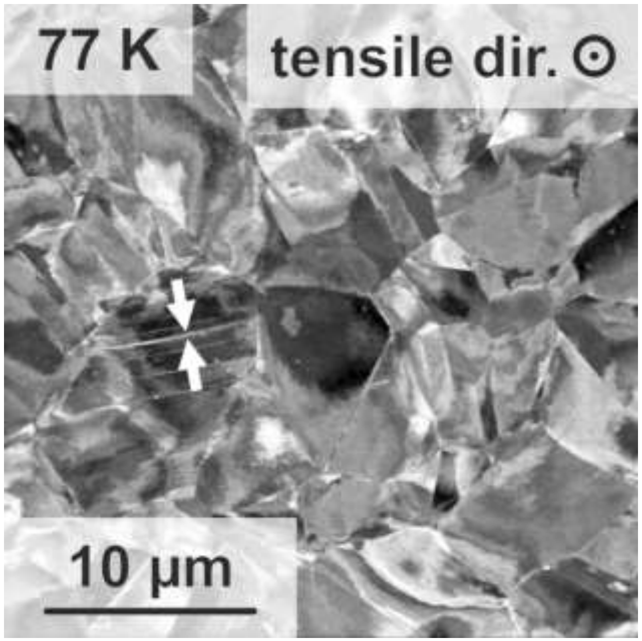


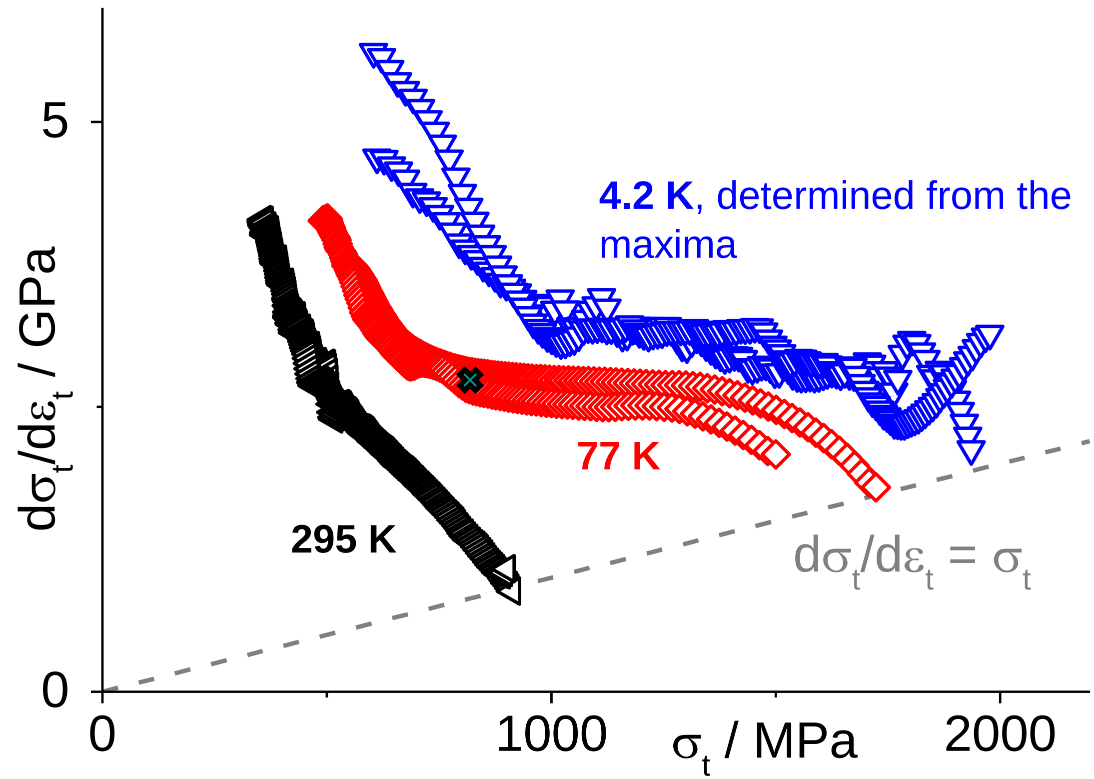
- Formation of a plateau at cryogenic operating conditions



Work-hardening

at very low temperatures



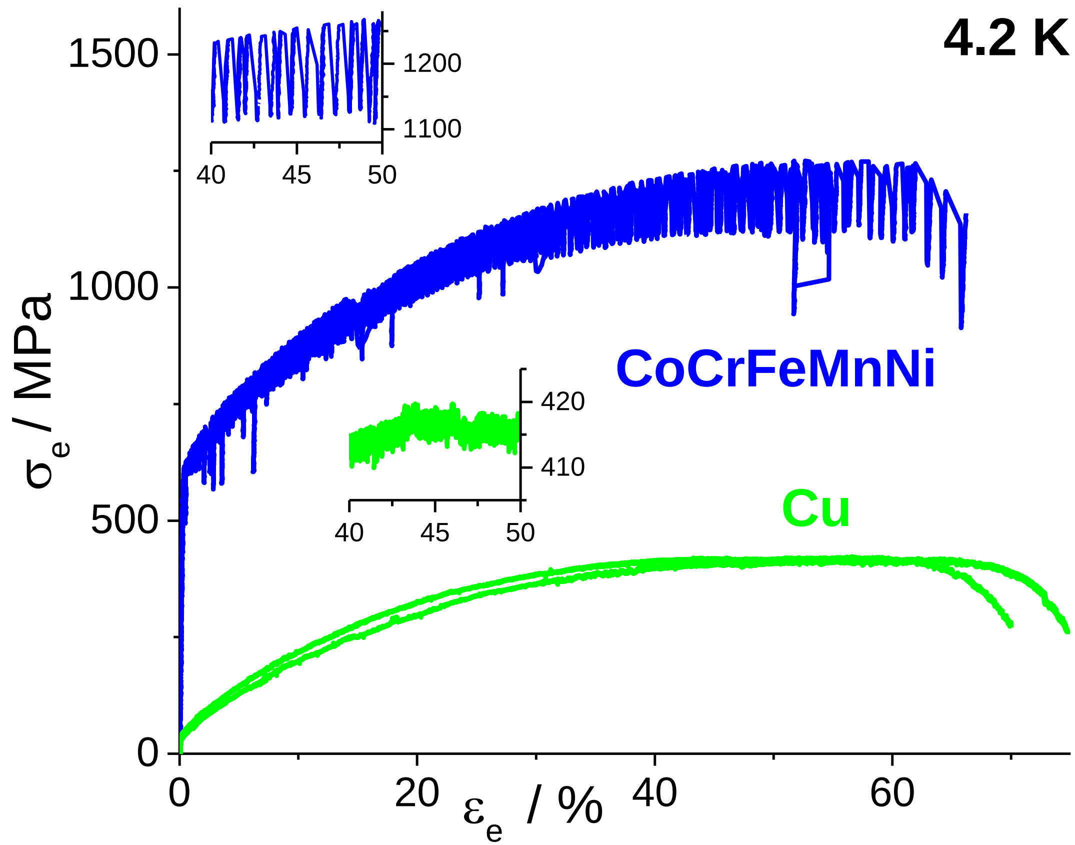


- Limited twin formation at deflection point
- ε-martensite was not observed

Serrated Plastic Flow

Origin of serrated plastic flow

- Serrations at cryogenic temperatures have been seen in many metals previously.
- Lack of coupling to He bath due to heat of deformation results in adiabatic heating
- Intrinsically driven by avalanche slip events and deformation twinning



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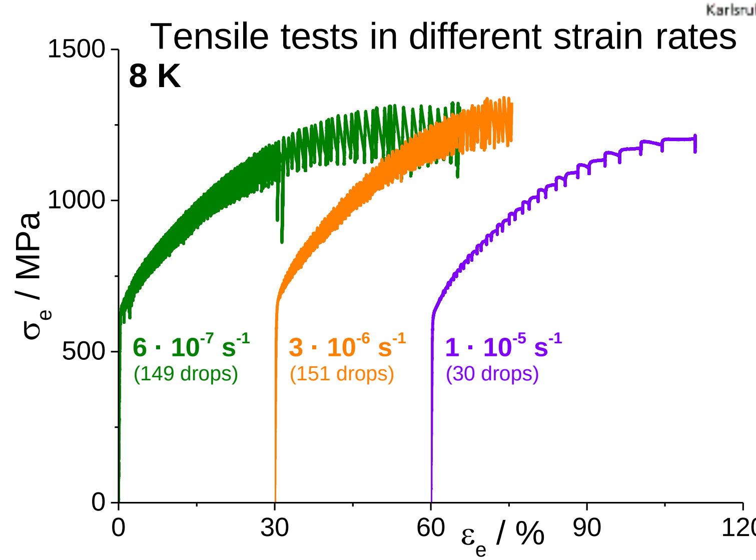
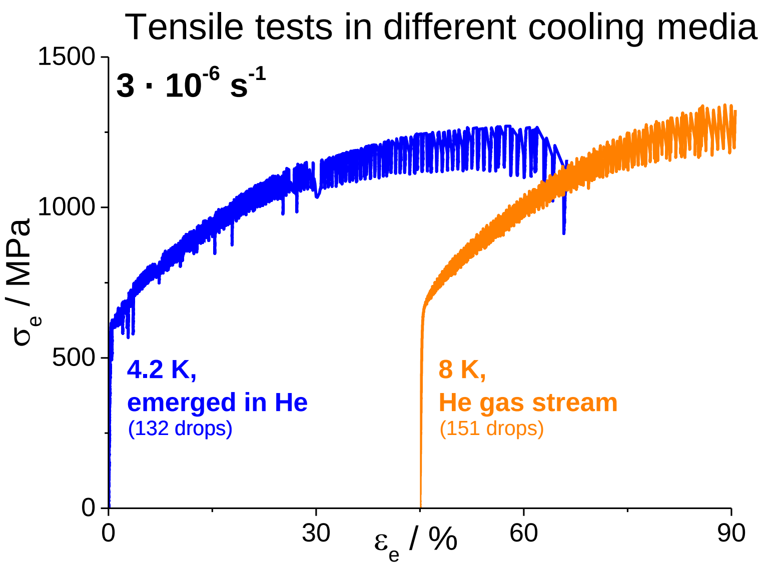
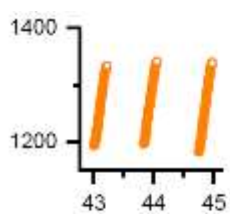
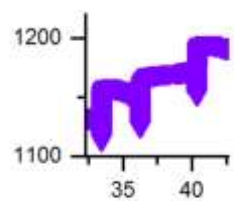
Serrated Plastic Flow



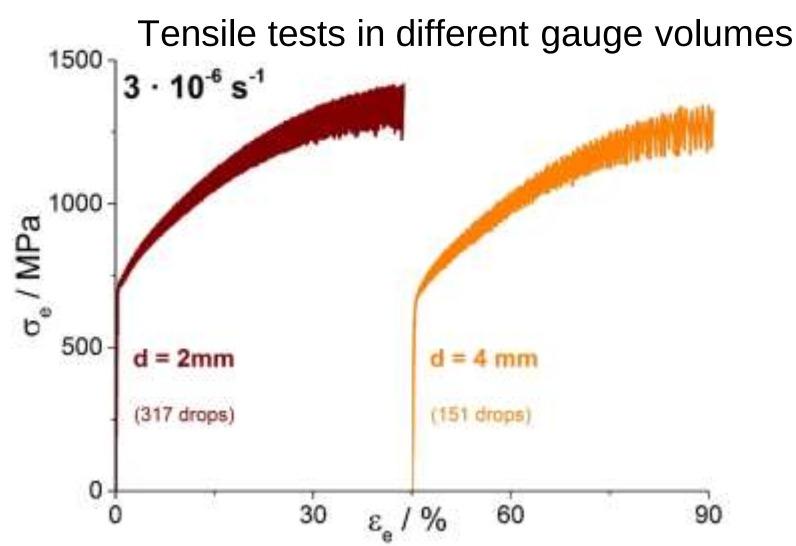




3.10^{-6} s^{-1} 8 K



1.10^{-5} s^{-1} 8 K



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Conclusions

Low Temperature Deformation of CoCrFeMnNi

- Extent of influence of twinning in the plateau initiation is questionable considering the twin density at that point
- Serrated plastic flow seems to be influenced by coupling with the cooling media, but extent of intrinsic influence needs to be verified as well

Outlook

Low Temperature Deformation of CoCrFeMnNi

- Interrupted tensile tests at various points of the plateau
- Estimate the extent of intrinsic behavior involved in the serrations
- The cause for the absence of ε-martensite needs to be understood

Thank you for your kind attention.

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