CONFLUENT

Nitinol With Improved Ductility

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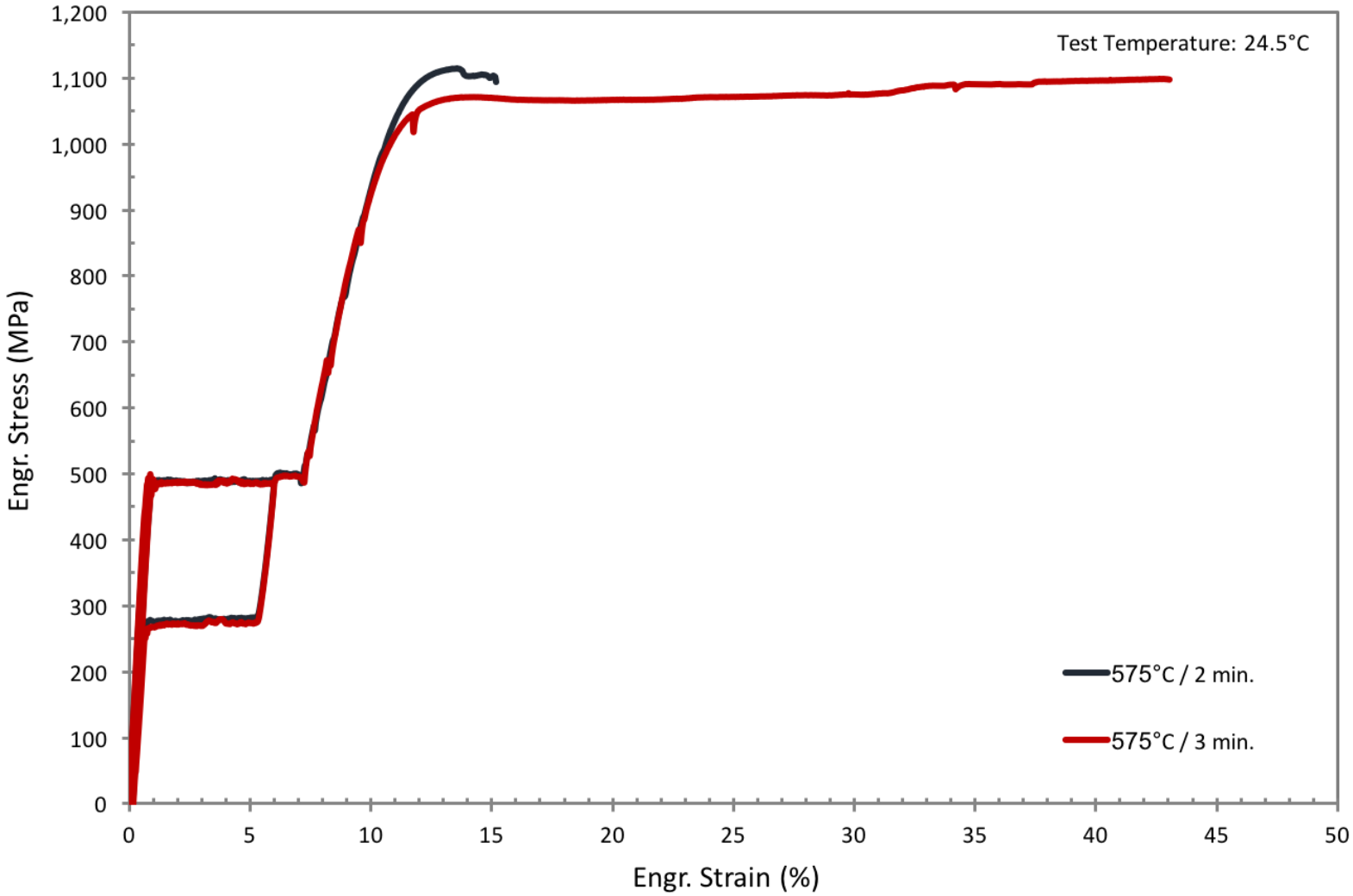
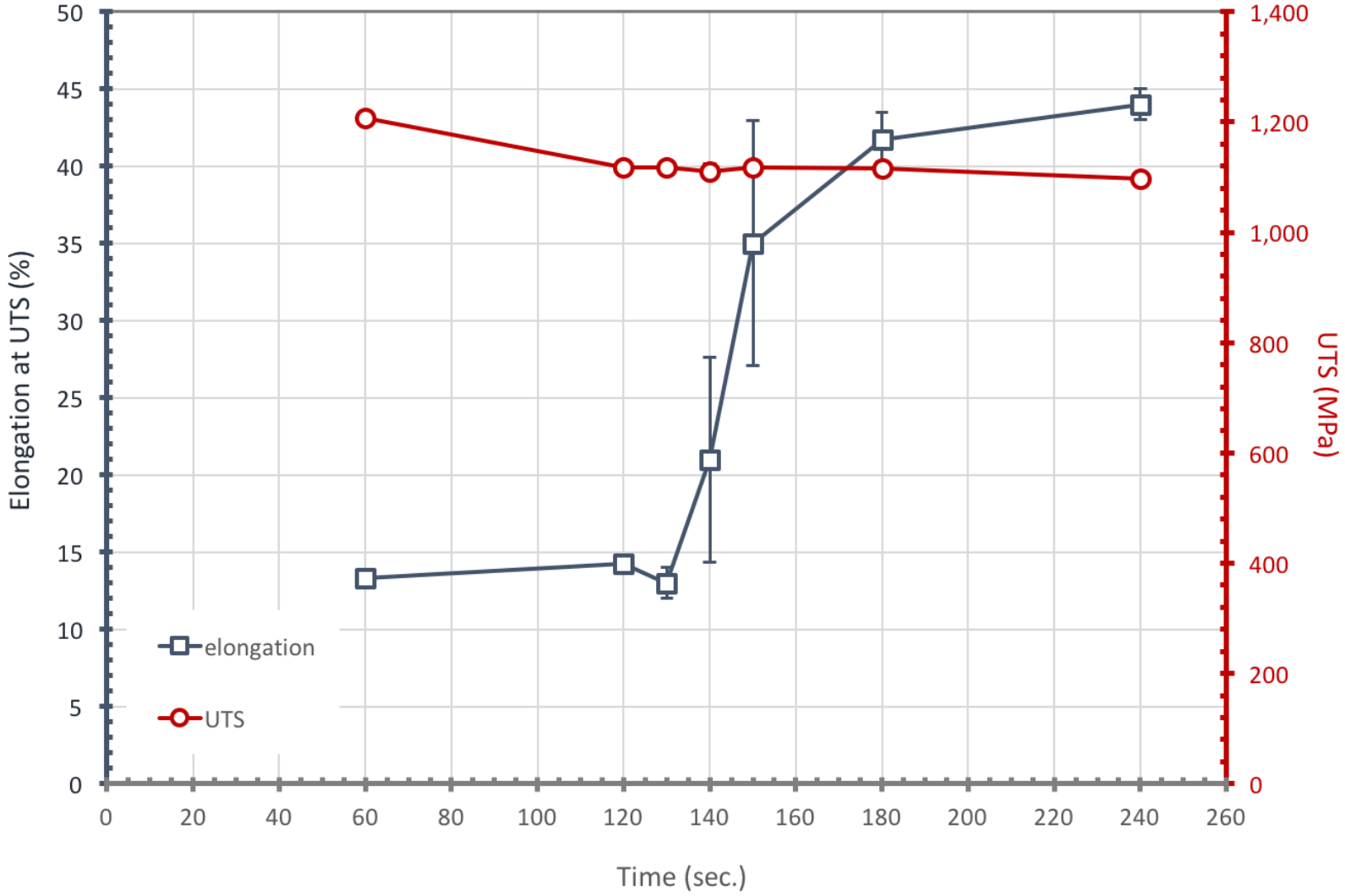
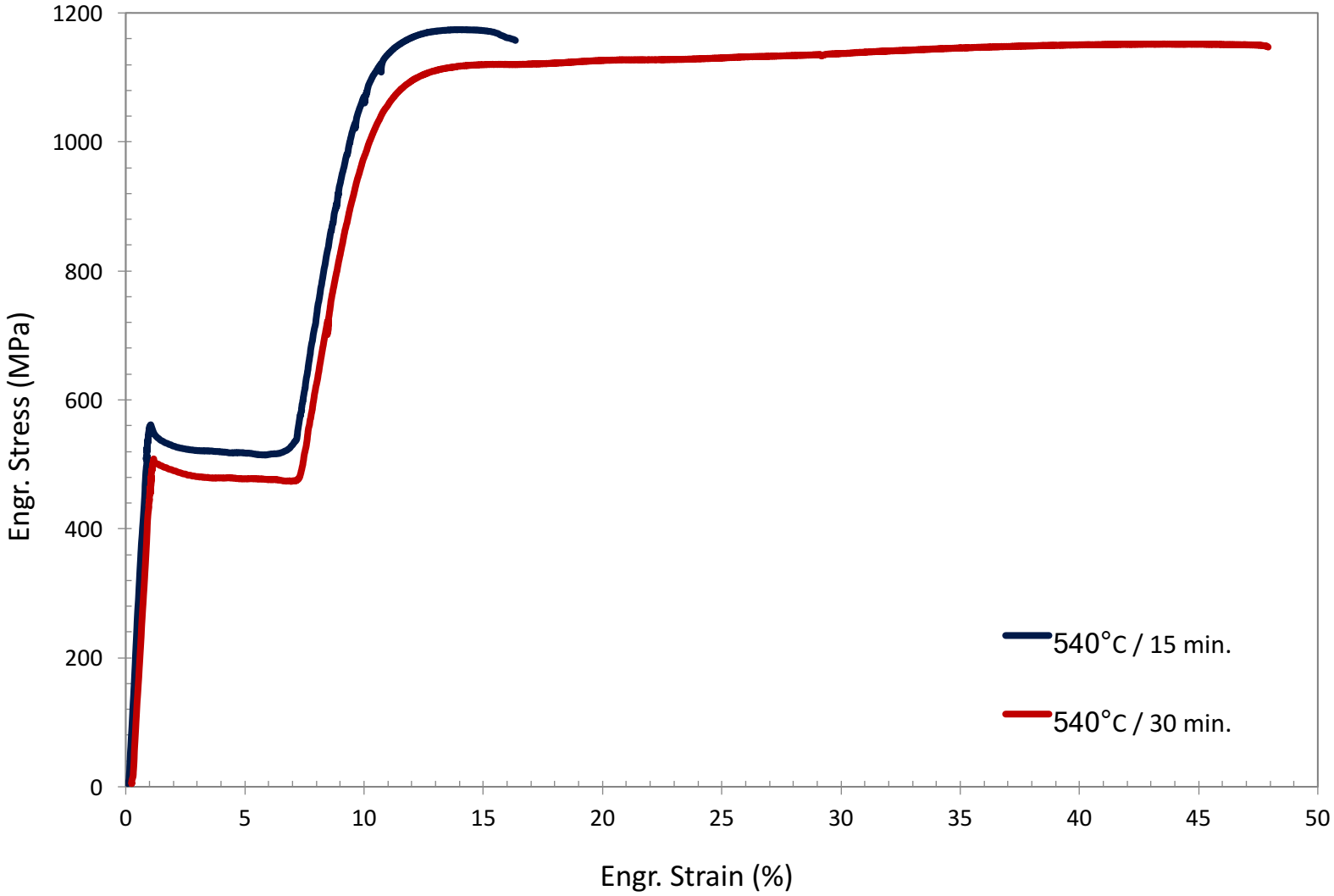
Ductility – Heat Treated at 575°C $Ni_{50.8}Ti$



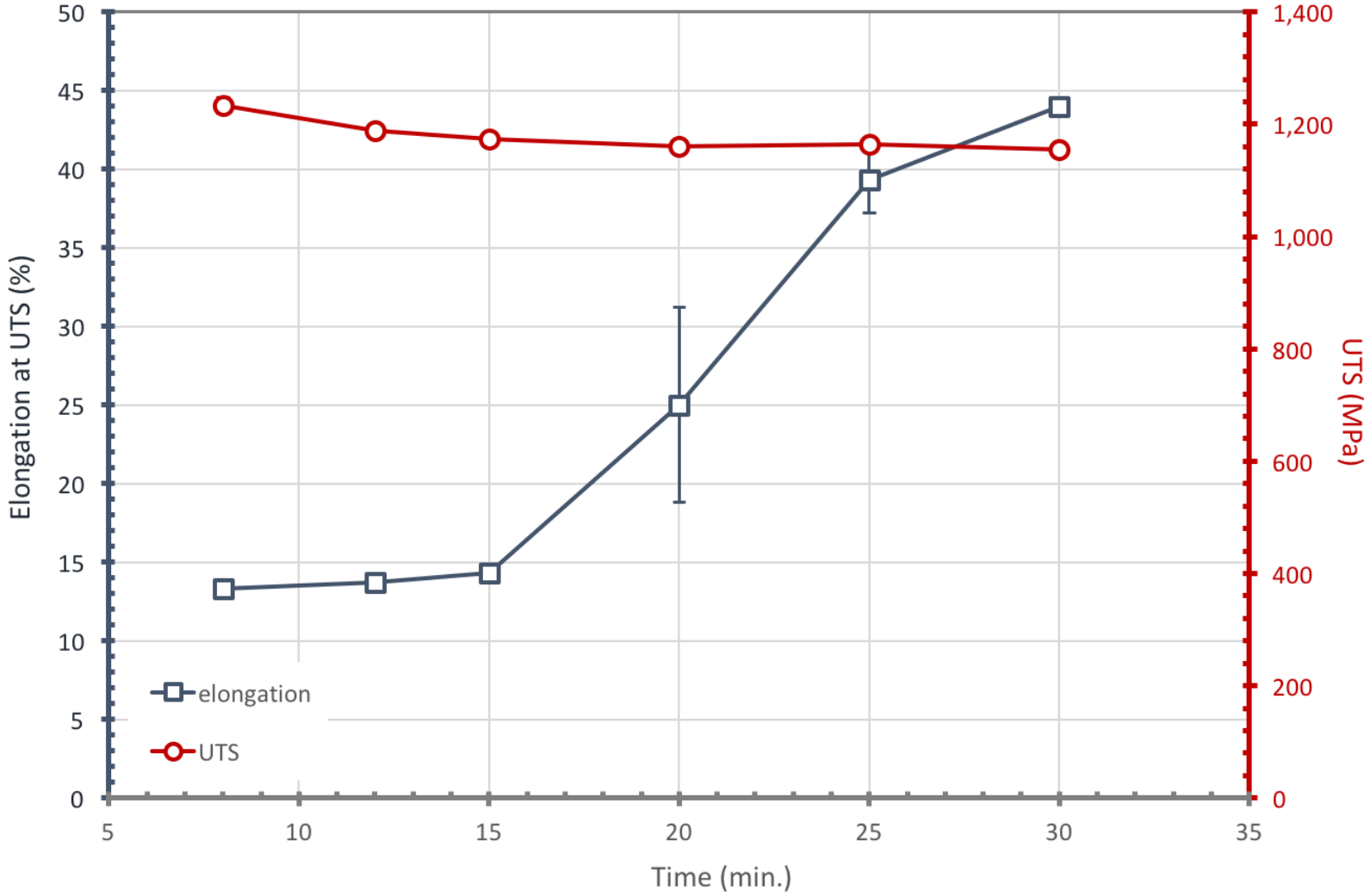
Ductility – Heat Treated at 575°C



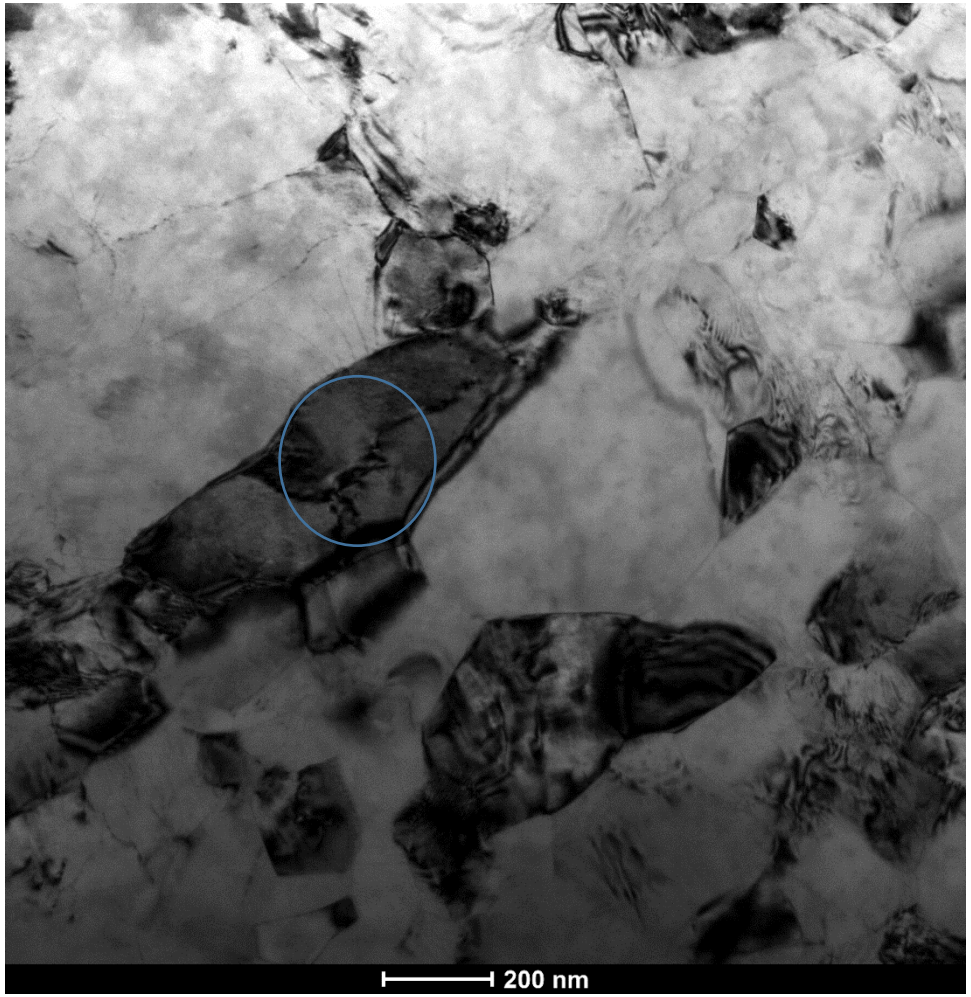
Ductility – Heat Treated at 540°C



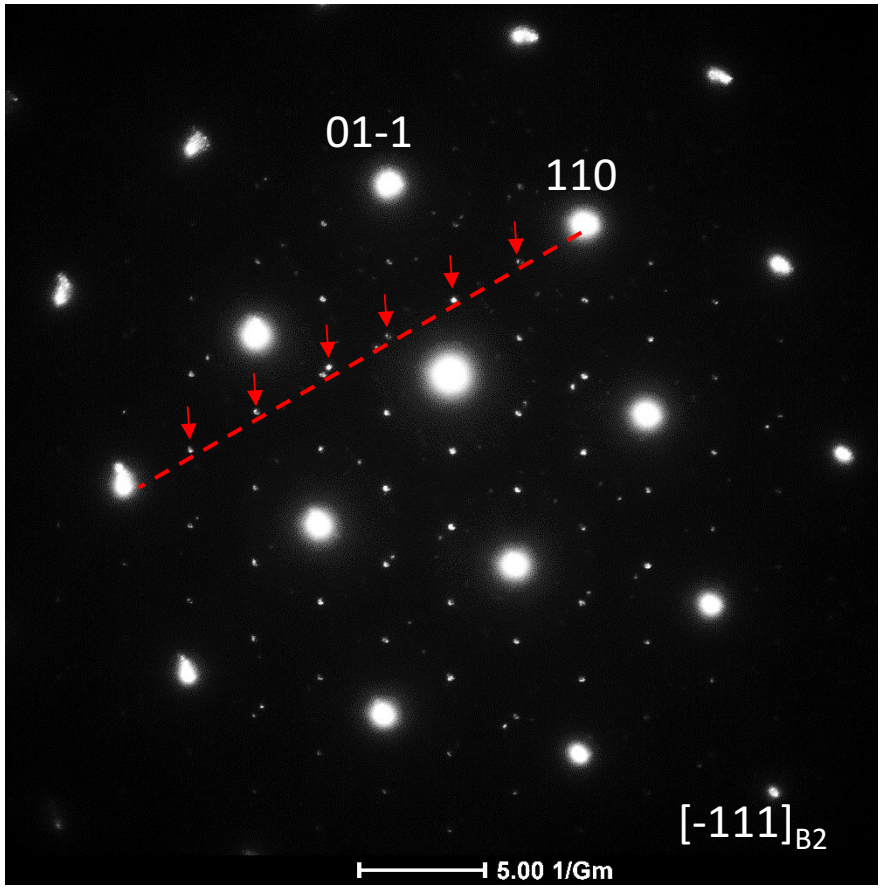
Ductility – Heat Treated at 540°C



TEM study- aged at 575 °C for 3 min. before deformation

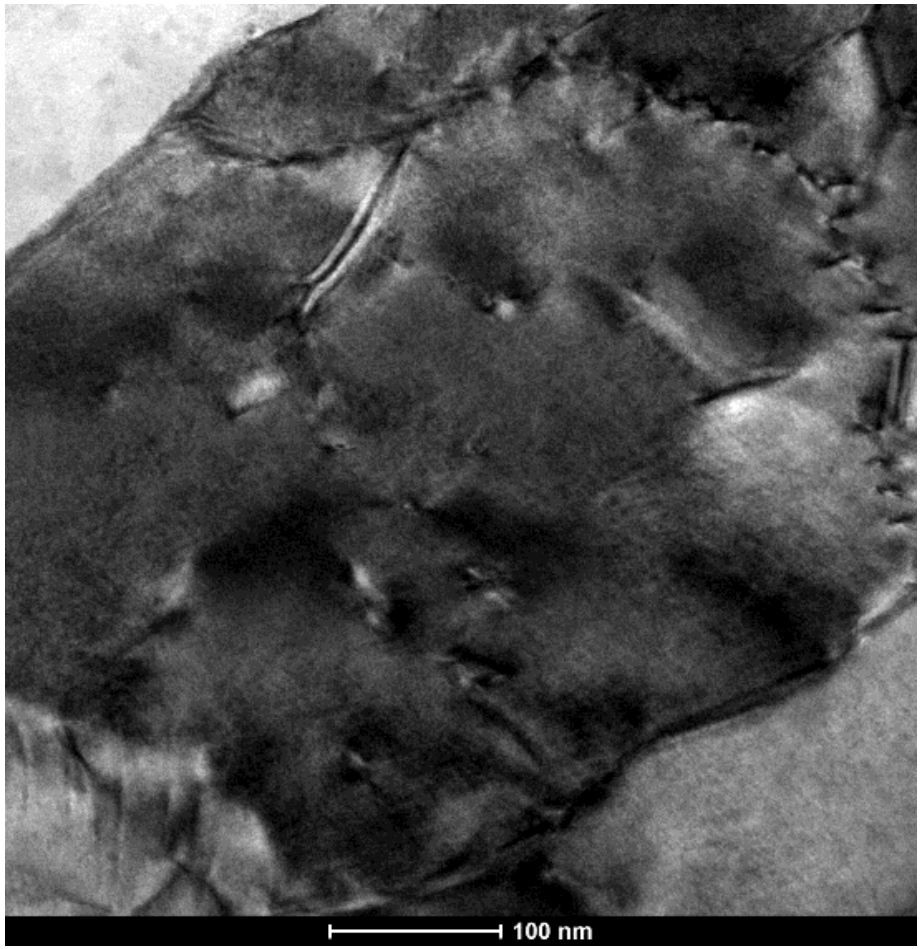


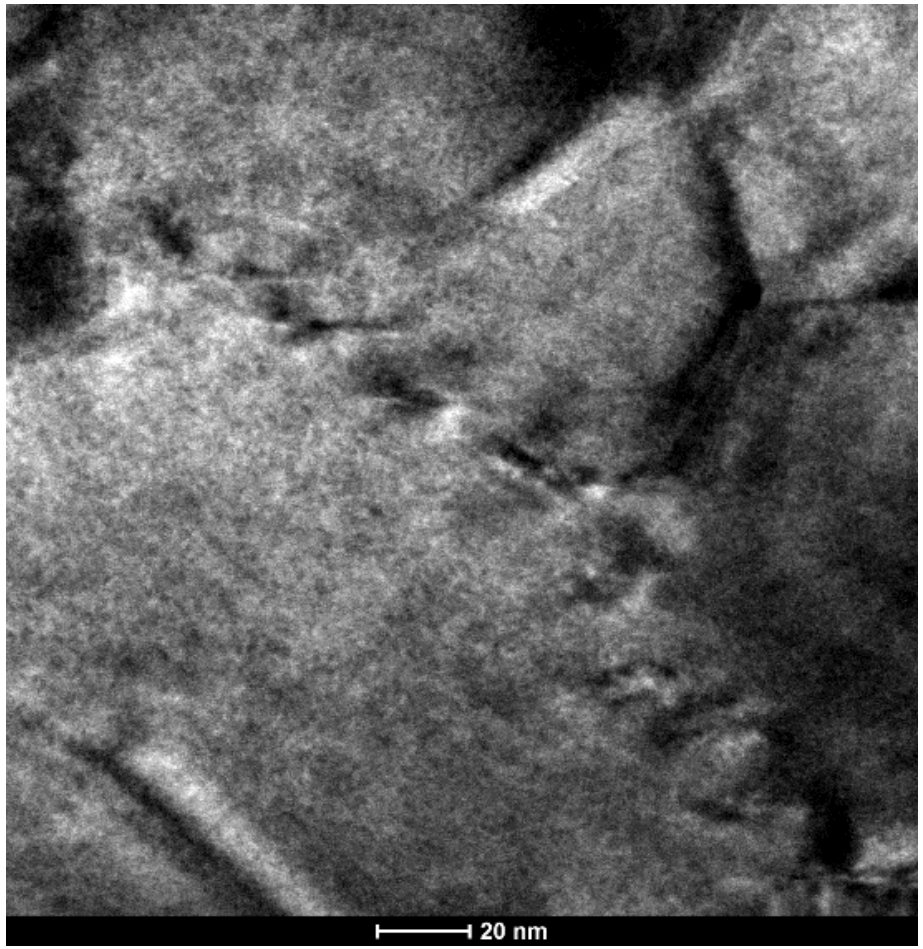
Conventional bright field micrograph



- Showing the <111> B2 zone axis and existence of 1/7<321> super reflections as indication of Ni_4Ti_3 precipitates.

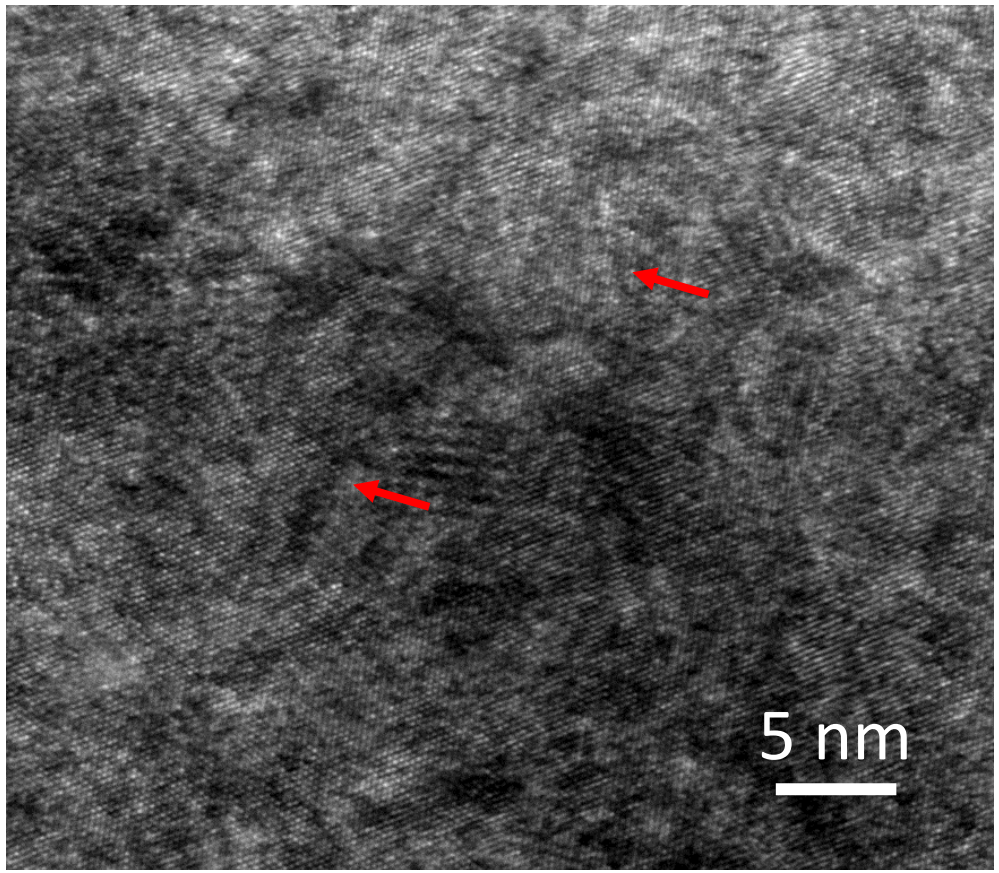
TEM study- aged at 575 °C for 3 min. before deformation

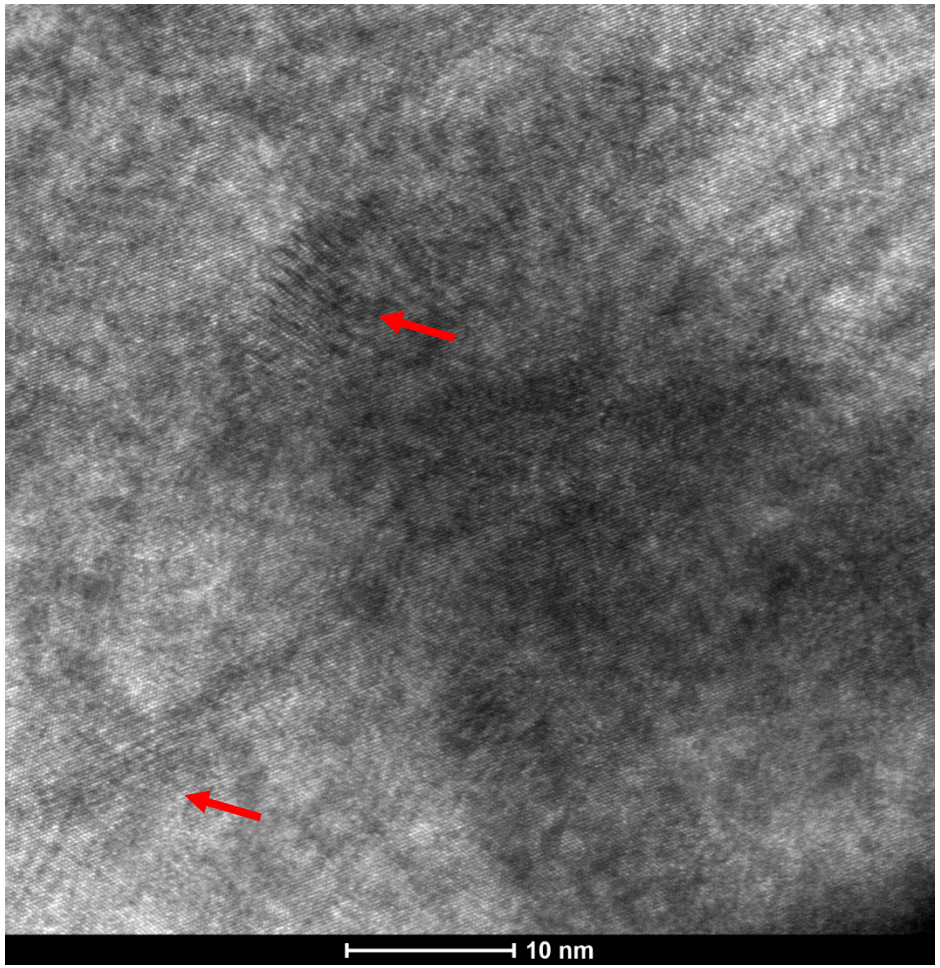




Precipitates are formed in a sequence due to formation of each one in the strain field of the other one which after deformation can form grain boundary

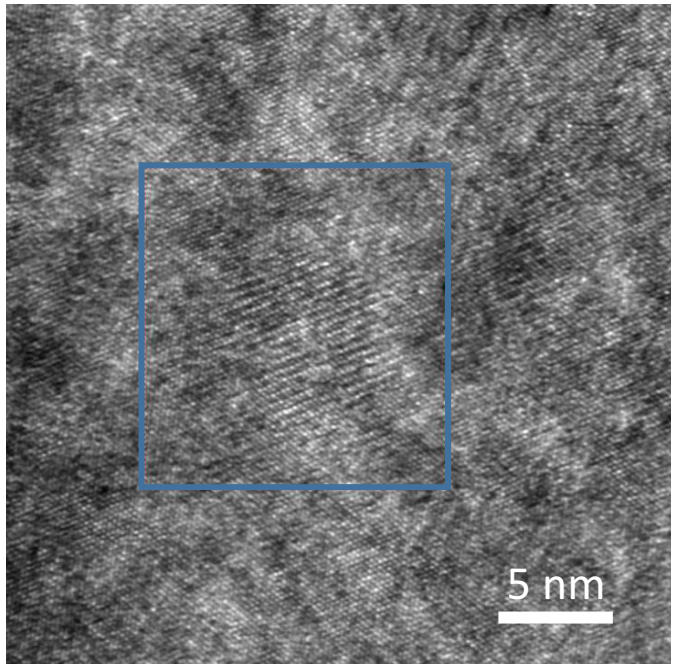
High resolution TEM technique

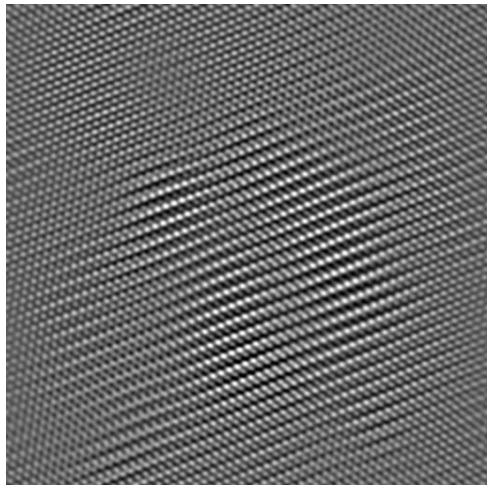




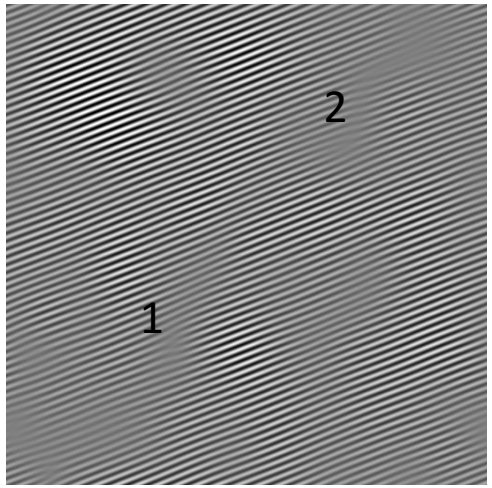
Nano Ni_4Ti_3 precipitates are indicated by arrows

High resolution TEM technique: most of the precipitates are coherent or semi-coherent



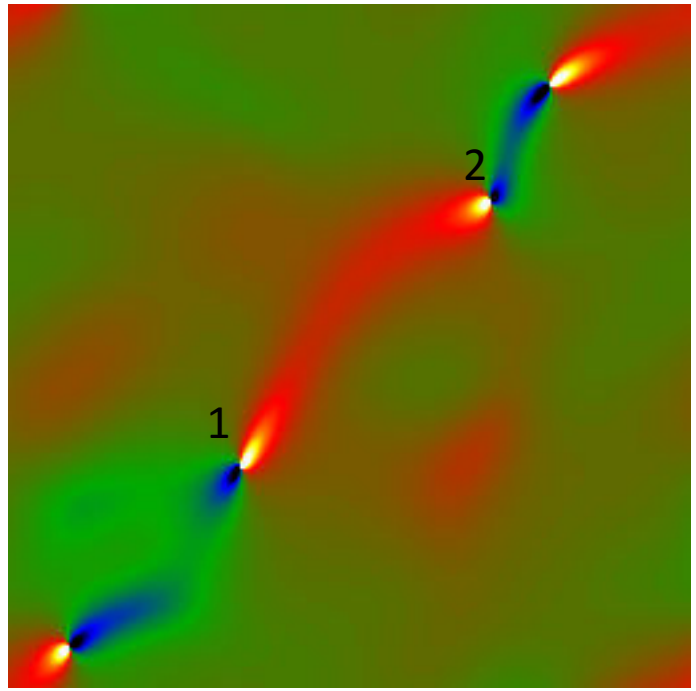


Filtered HRTEM image



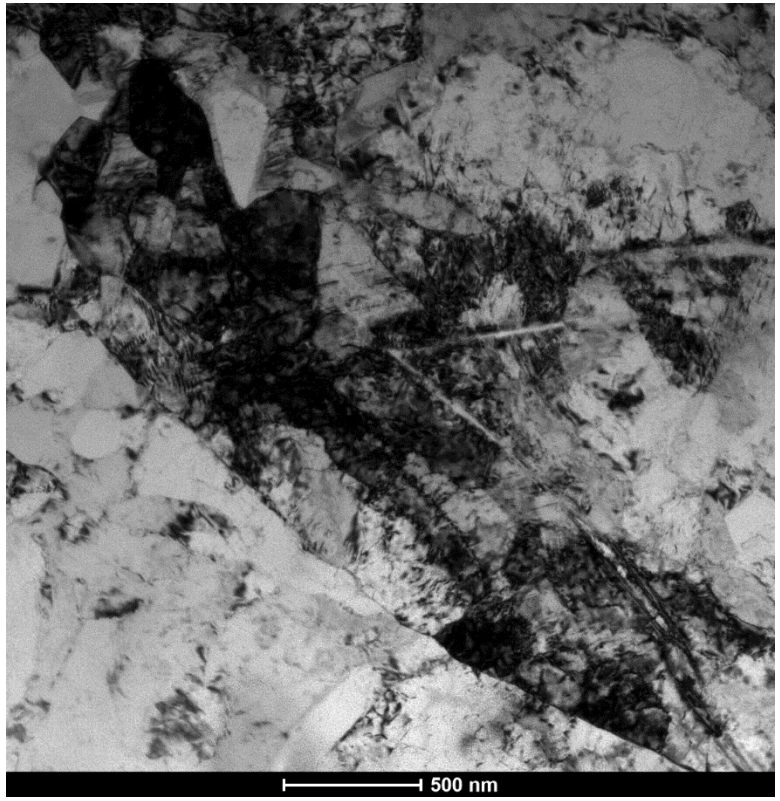
Inverse fast Fourier transform

Local g-map

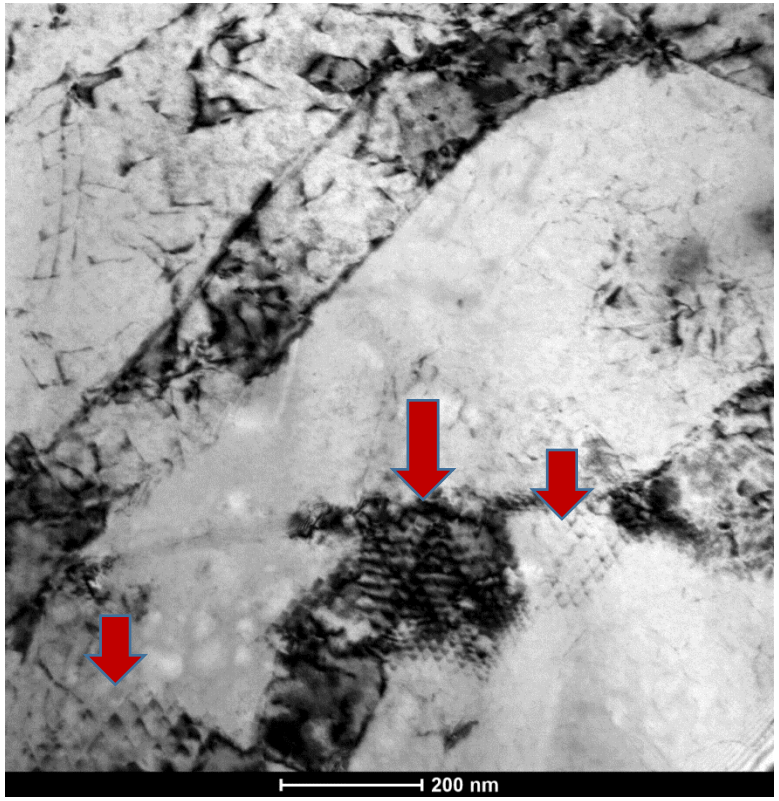


Formation of two misfit dislocation in the interface matrix/ precipitate

TEM study: After deformation 9%

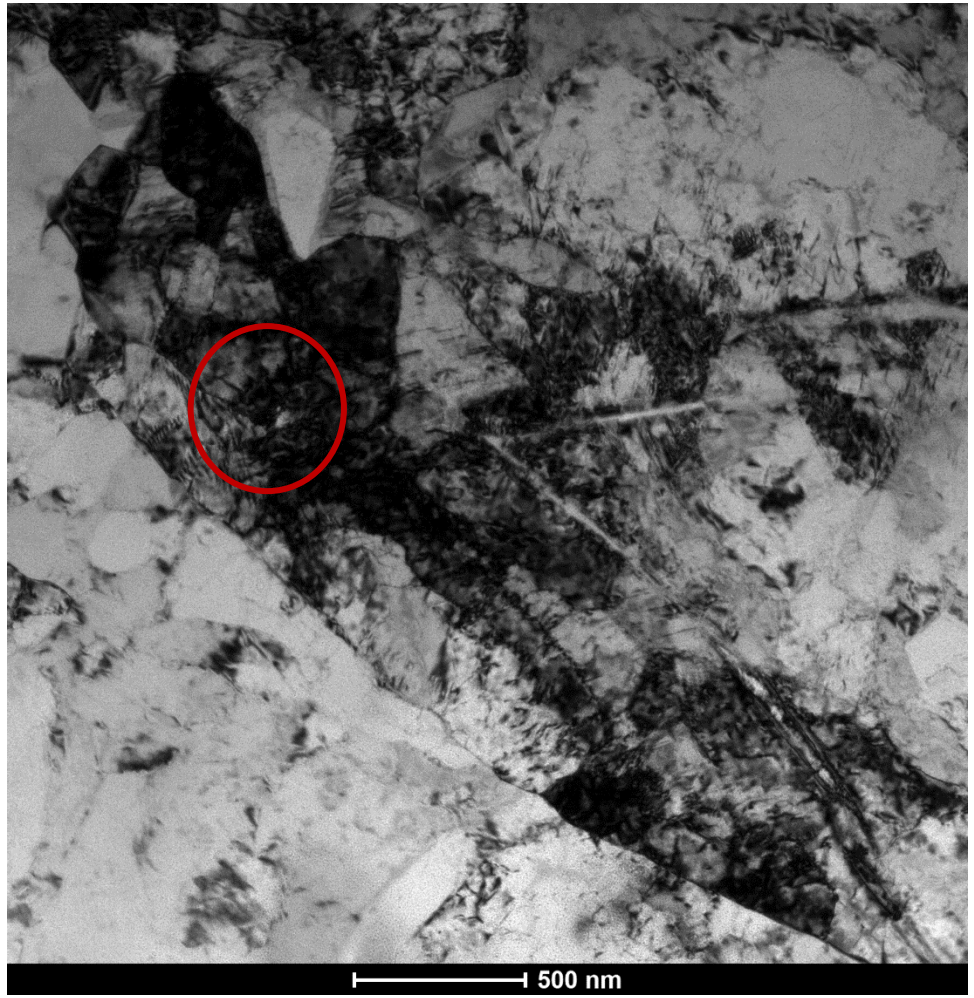


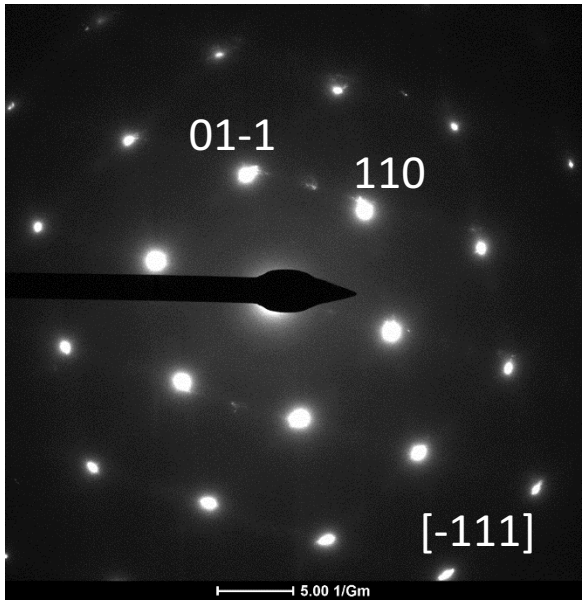
Formation of low angle grain boundaries, residual martensite and existence of the morphology of martensite plates



Formation of low angle twist boundary was also confirmed by observation of screw dislocations network inside grains.

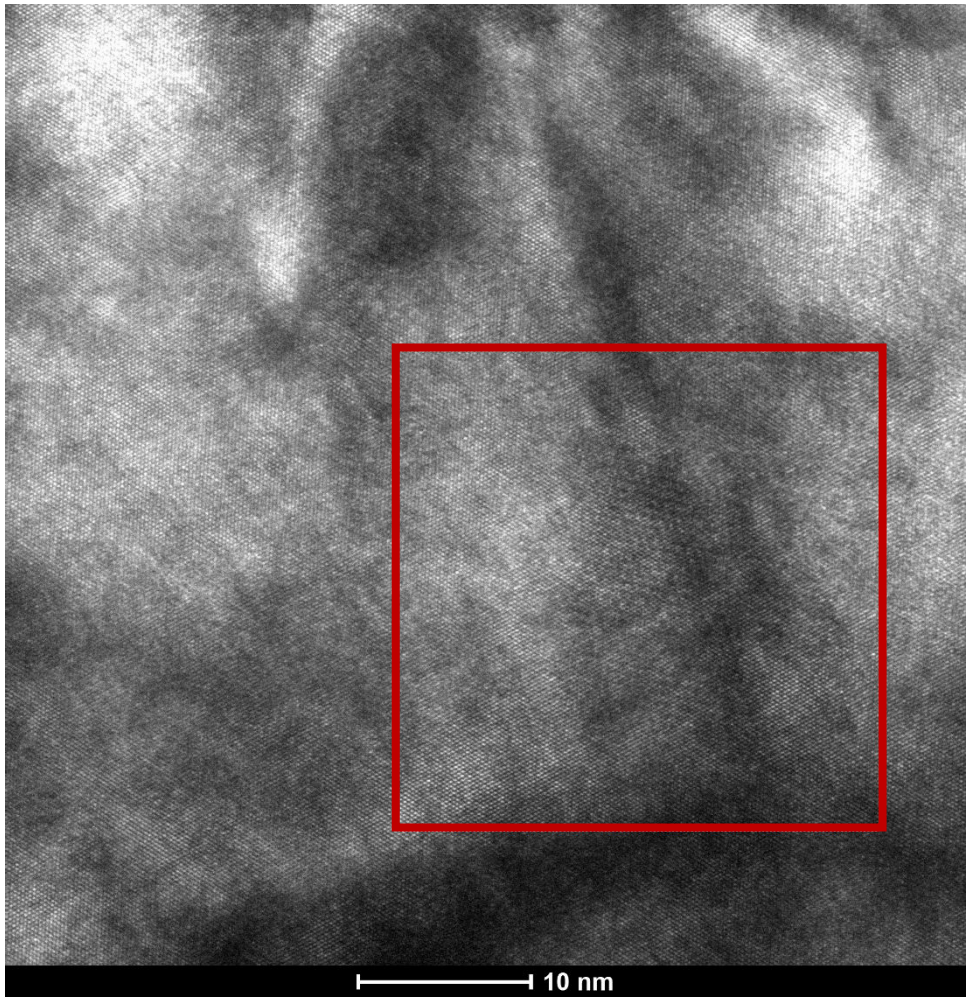
Diffraction study: No reflections related to precipitates were detected

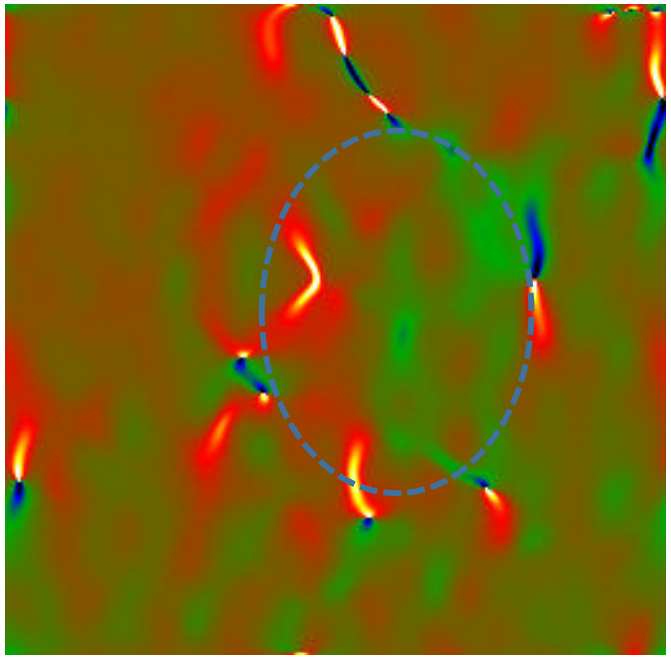


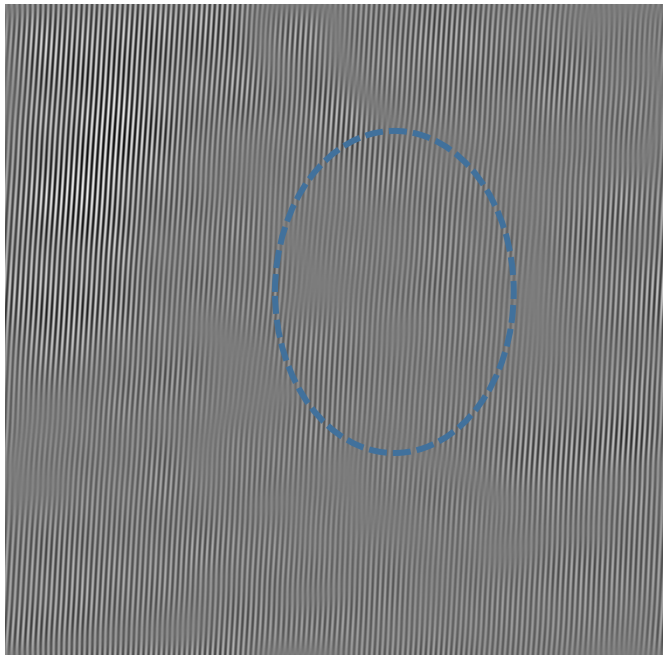


- Smaller, coherent precipitates are not only sheared, but are actually dissolved by the passage of dislocations due to increase of the surface energy of sheared particles

High resolution TEM technique

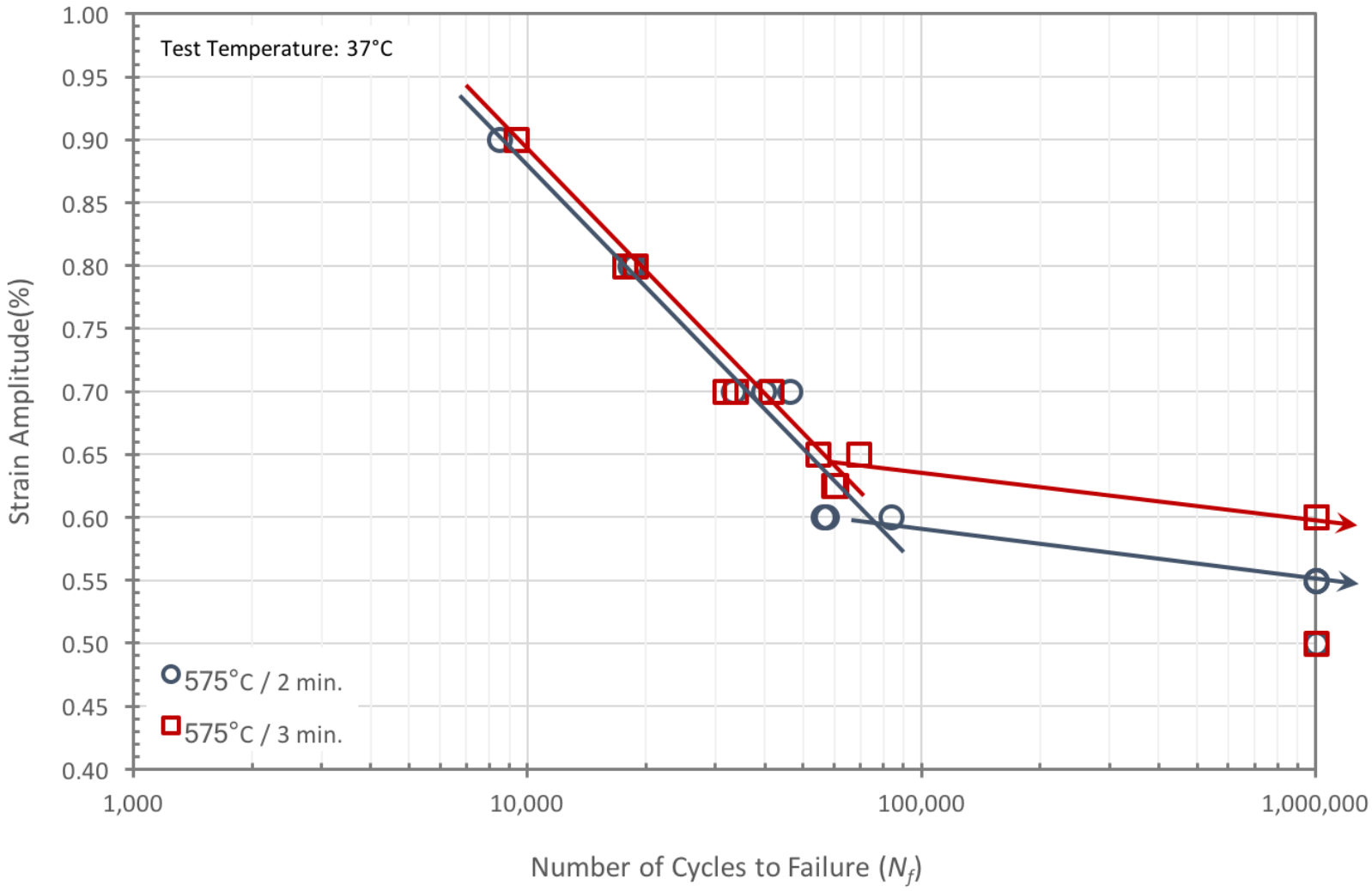






- Residual larger precipitates but became incoherent with higher number of dislocations around them.
- Larger precipitates appear to accumulate dislocations during Orowan looping. After forming Orowan loop, it shrinks onto the precipitate-matrix interface.

Rotary Bending Fatigue - Results



Conclusion

- An unusually sudden and dramatic increase in ductility is observed during ageing of cold worked Ni-rich NiTi at 575 °C-3min or 540 °C-30min.

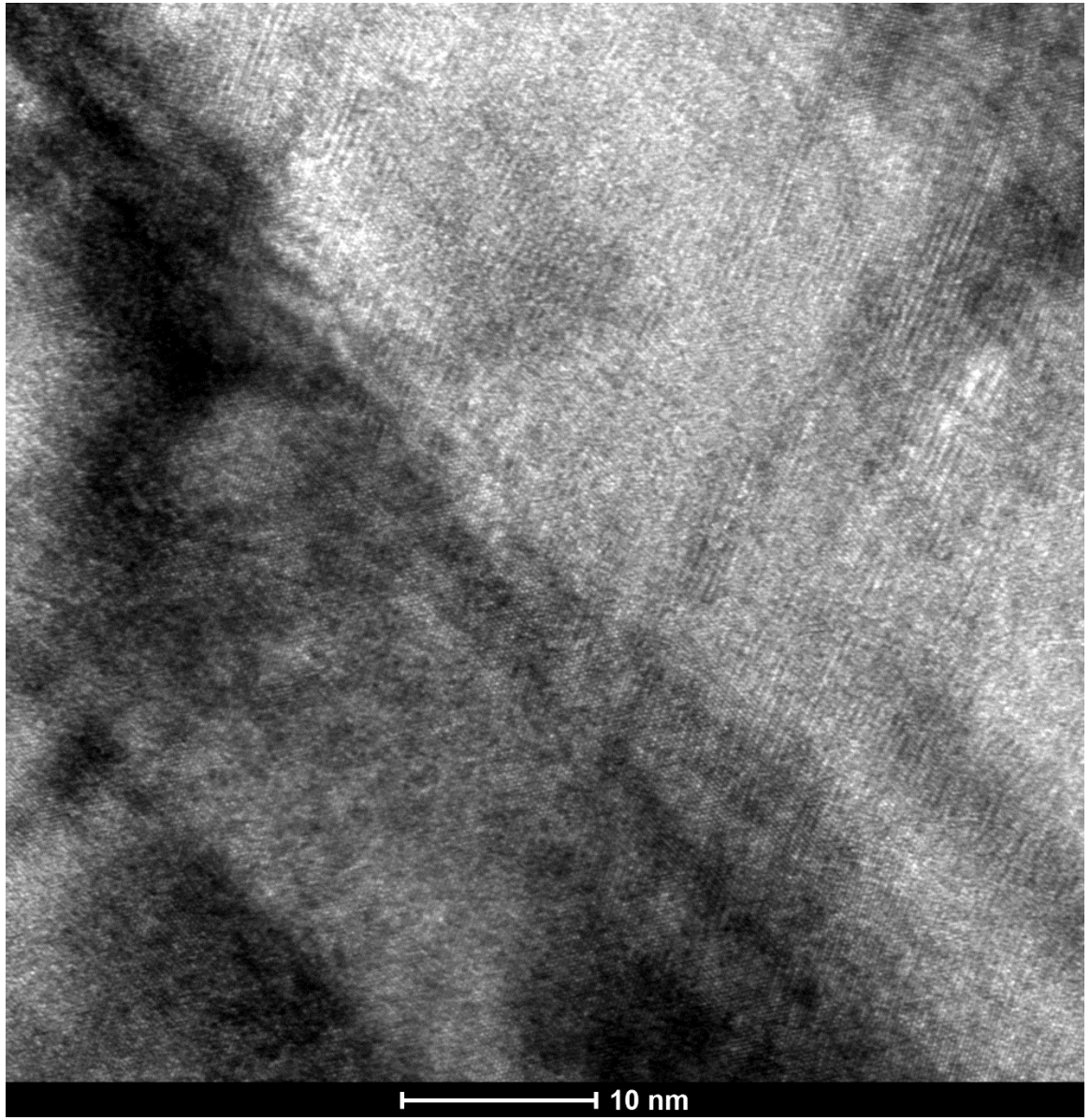
- During deformation smaller, coherent precipitates are sheared and then dissolved by the passage of dislocations.

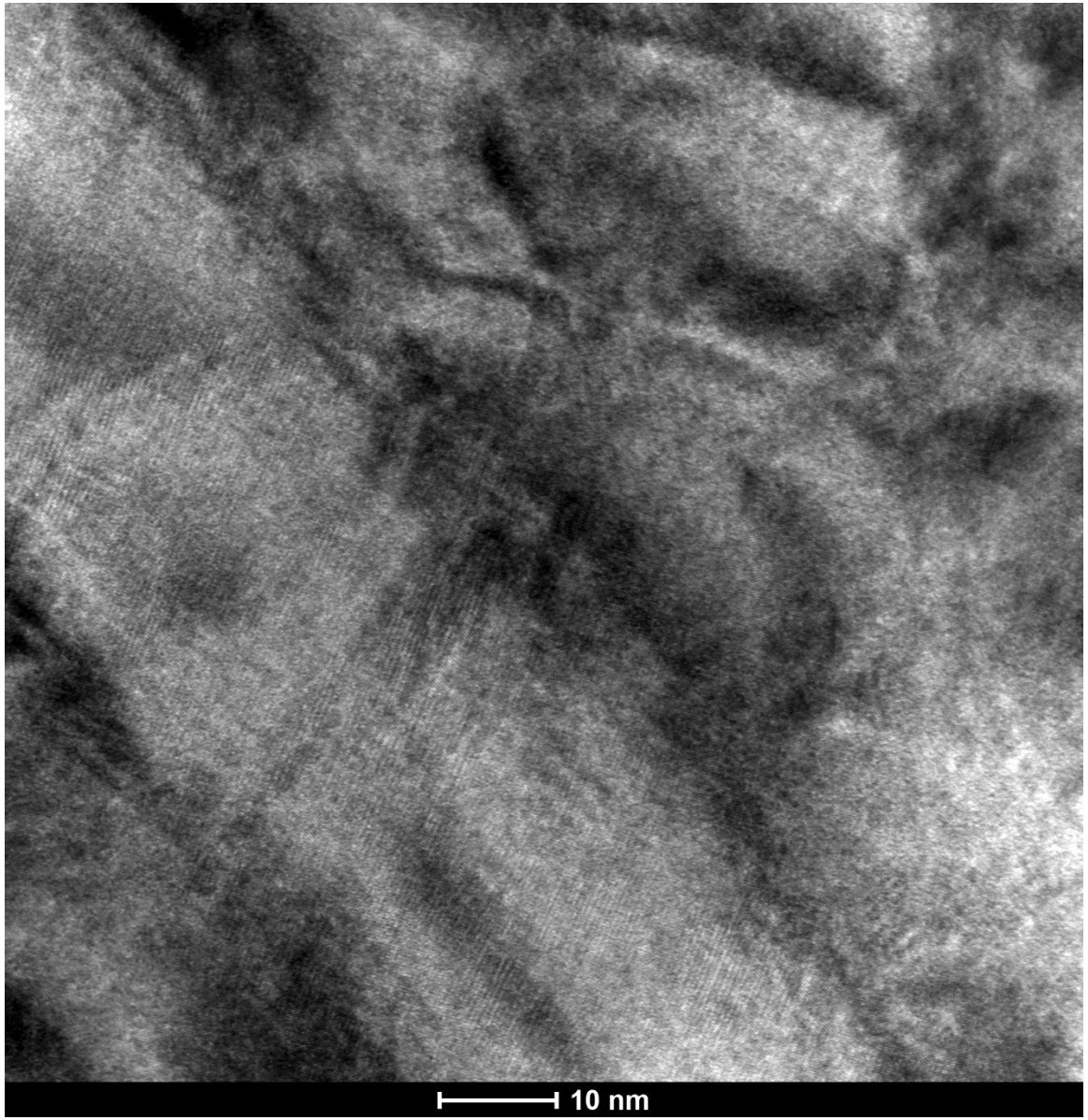
- Larger precipitates appear to accumulate dislocations, indicative of Orowan looping.

- proposed mechanism:

smaller coherent precipitates provide initial hardening (by shearing precipitates) till precipitates dissolve and their hardening effect is lost and fracture occurs (575/2min). However, in the presence of coherent and semi-coherent precipitates, semi-coherent larger precipitates are able to survive deformation and thus ductility is increased.

Thank You





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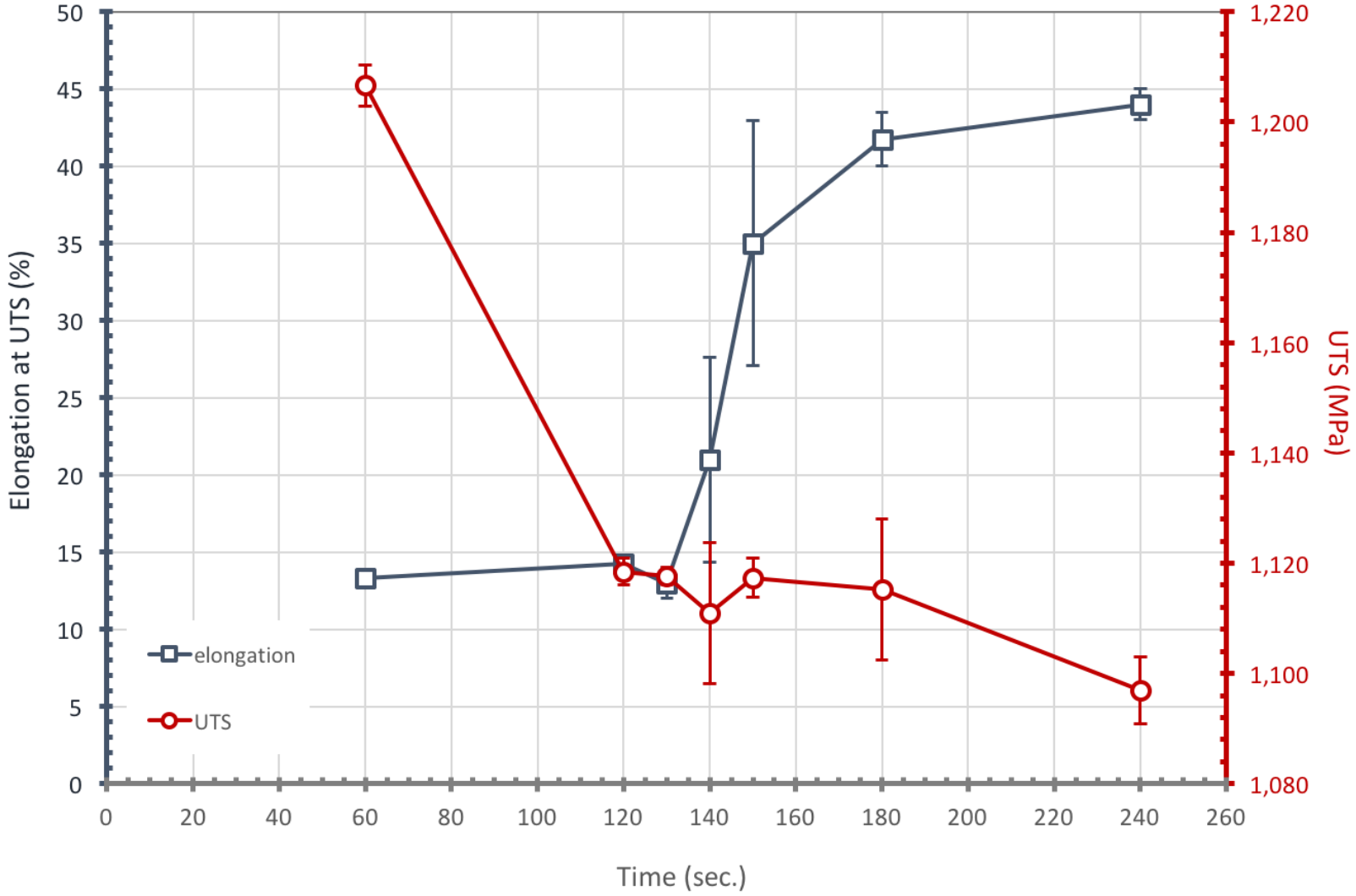

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