

Materials research for nuclear fusion energy - analysing the flow properties of eurofer97

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OBJECTIVES:

- 1) Analyse flow properties of lab-cast Eurofer + train analytical methods.
- 2) New method for obtaining temperature dependent yield strength from a single sample.

Scanning electron microscope

Visualize difference between ductile and brittle fracture + understand their origin

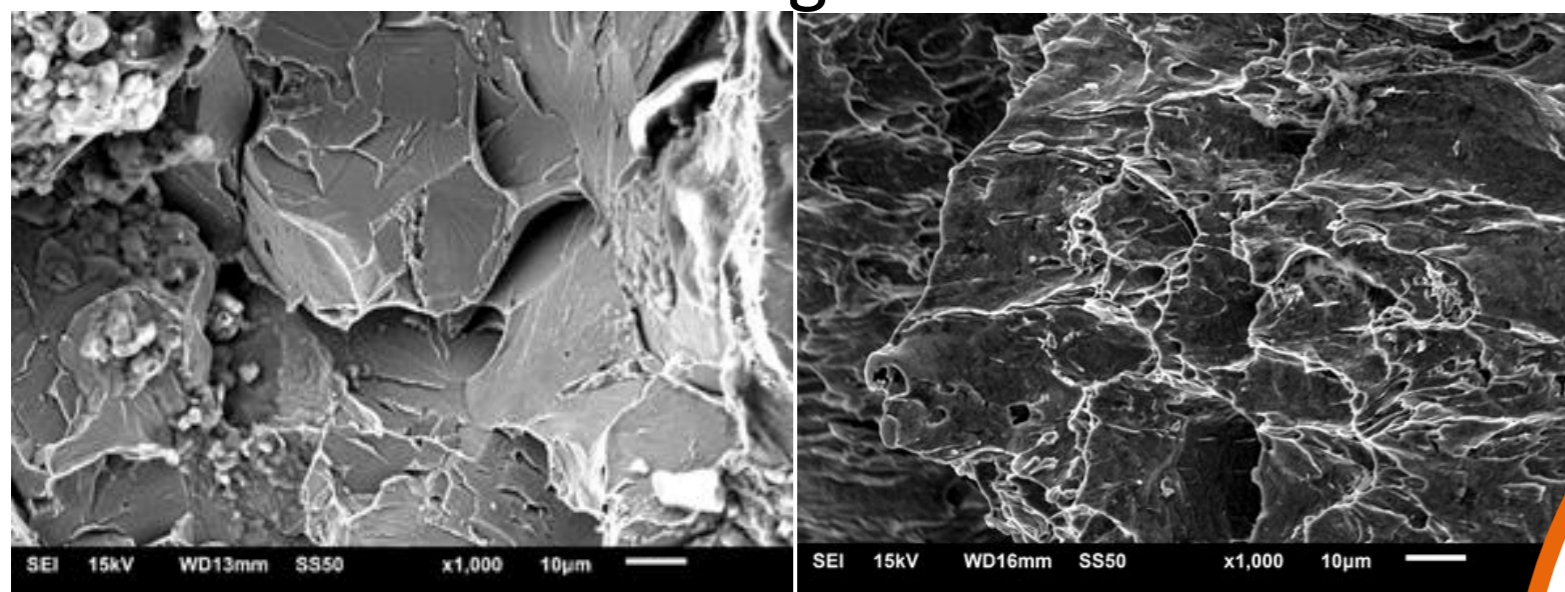


Figure 2: Scanning electron microscope image of fracture surface at x1000 magnification. Left: brittle. Right: ductile.

Charpy impact test

Locate ductile-to-brittle transition temperature (DBTT)

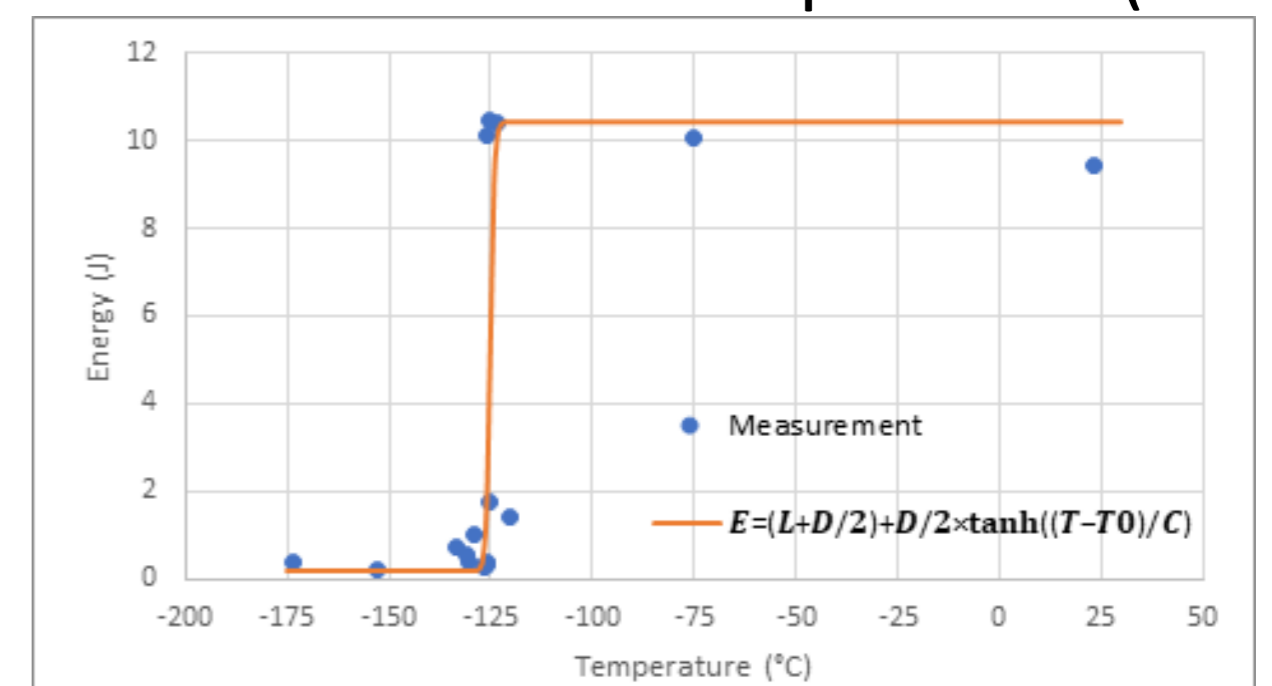


Figure 3: Energy vs temperature measurement from Charpy test.

Vickers hardness test

Measure hardness as precursor to tensile test + see effect of work hardening

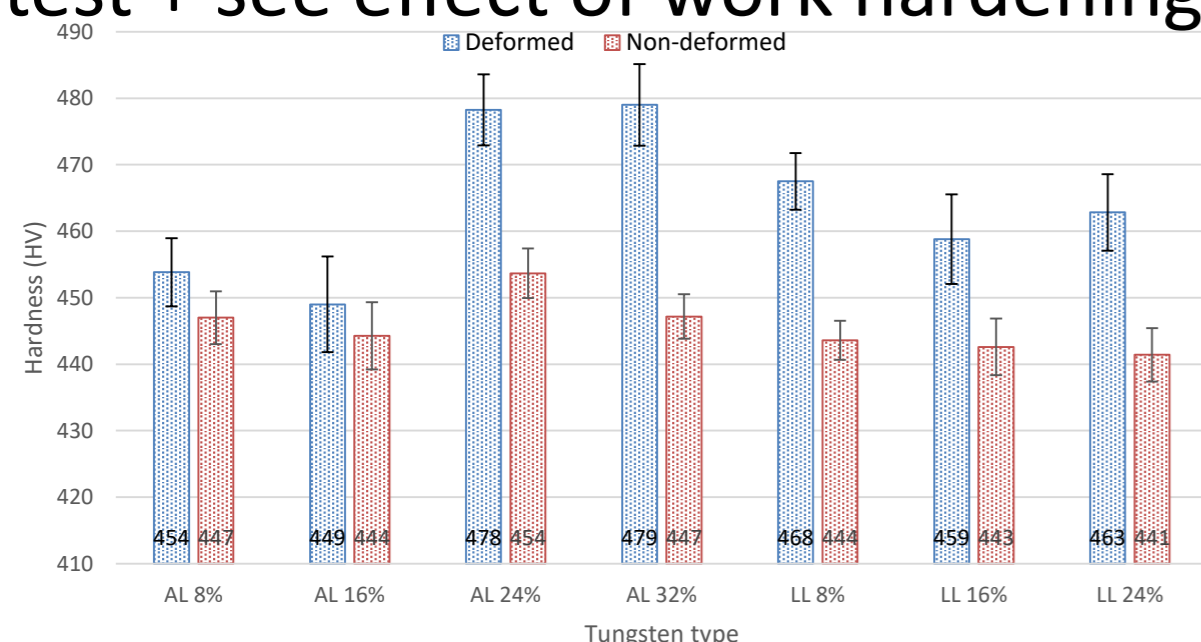


Figure 4: Hardness of deformed and non-deformed tungsten



EUROFER97

Figure 1: Eurofer sample

Tensile test

Stress-strain curves

Temperature dependent yield strength

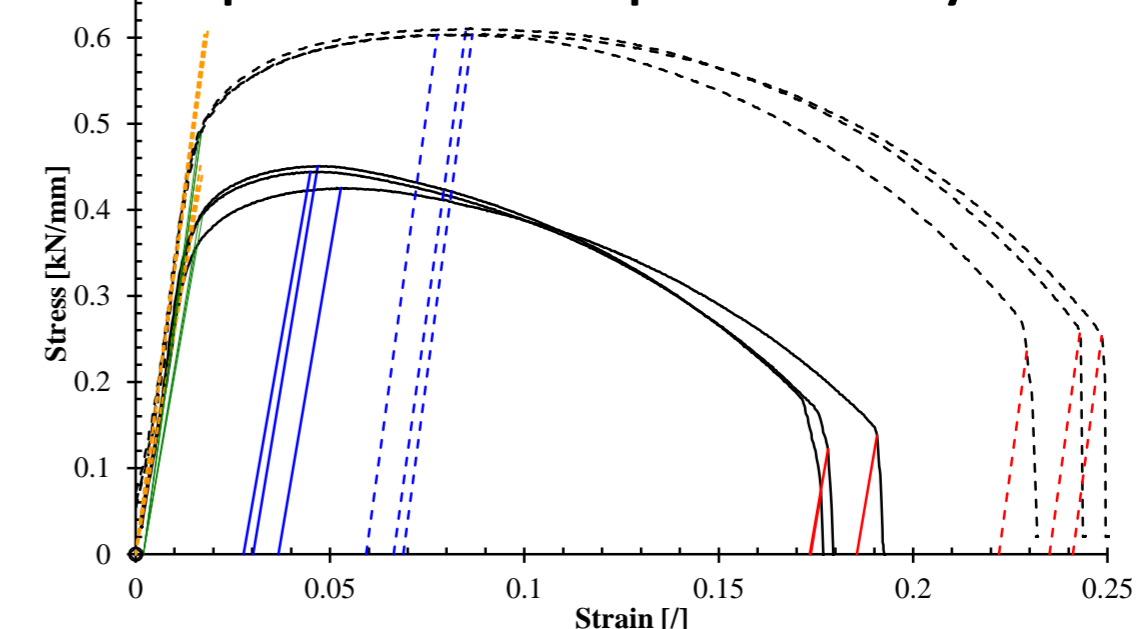


Figure 5: Stress vs Strain (Reference) 300°C (full line) and 23°C (dashed line)

Temperature dependent yield strength

Validation of interrupted testing at fixed loads
 Practicing interrupted test procedure at nominal load rate
 Verifying accuracy of results (Fig. 6)
 Application: acquiring the temperature dependent yield strength from single sample: 300°C → 200°C → 100°C → 23°C (Fig.)

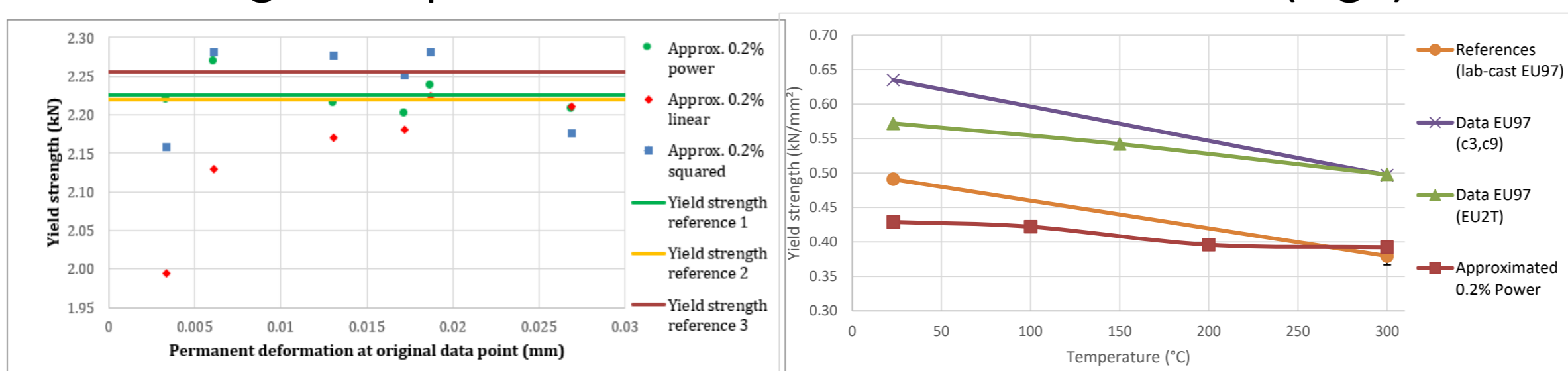


Figure 6: Approximated yield strength at 23°C compared to reference

Figure 7: Approximated yield strengths at different temperatures compared to measurements

Conclusions

Objective 1:

- All techniques successfully performed
- DBTT -80°C [1] → -125°C significant improvement due to treatment

Objective 2:

- Temperature dependent yield strength procedure verified and applied
- Good approximation at 300°C
- Poor approximation at 23°C due to inaccuracy of power function at high strain

[1] G. Mazzone, et al. "Choice of a low operating temperature for the DEMO EUROFER97 divertor cassette" *Fusion Engineering and Design*, vol. 124, pp 655-658, Nov 2017.

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