

Effect of the heat-induced corrosion on the mechanical behavior of Eurofer97 derived by instrumented indentations

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Motivation

Further characterizations of the mechanical behavior of Eurofer97 up to 550 °C are required. A new instrumented macroindentation device was designed [1] and is currently constructed for that purpose (see Poster Session D 15-267). It is featured by a vacuum chamber to minimize oxidation at the sample during testing at high temperature. The impact of heat-induced corrosion effects on the surface and the mechanical properties is examined here in advance by means of Auger electron spectroscopy-AES, scanning electron microscopy- SEM, and instrumented indentations at room temperature (the indentation procedure is detailed in [2]).

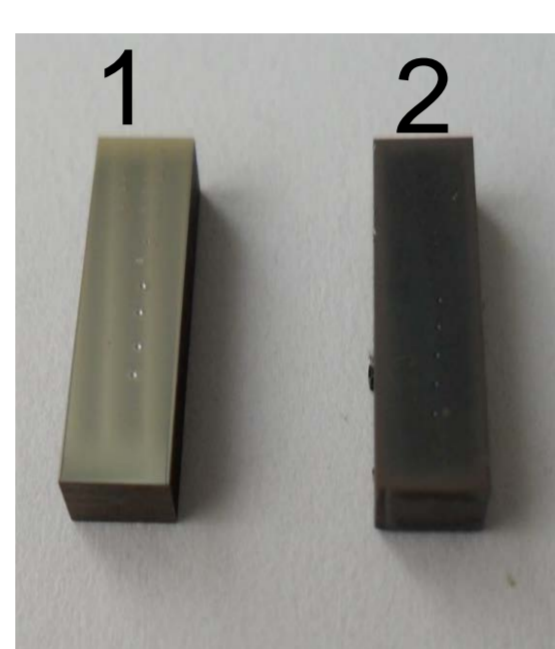
Sample preparation

Materials: Eurofer97 (9 wt.%-Cr)

Polishing: 3 µm diamond suspension

Specimens: 13x4x3 mm³

(halves of irradiated Charpy V-notched small-sized specimens)



1: vacuum-heated sample
(High vacuum-HV: 10⁻⁵ mbar)

2: air-heated sample

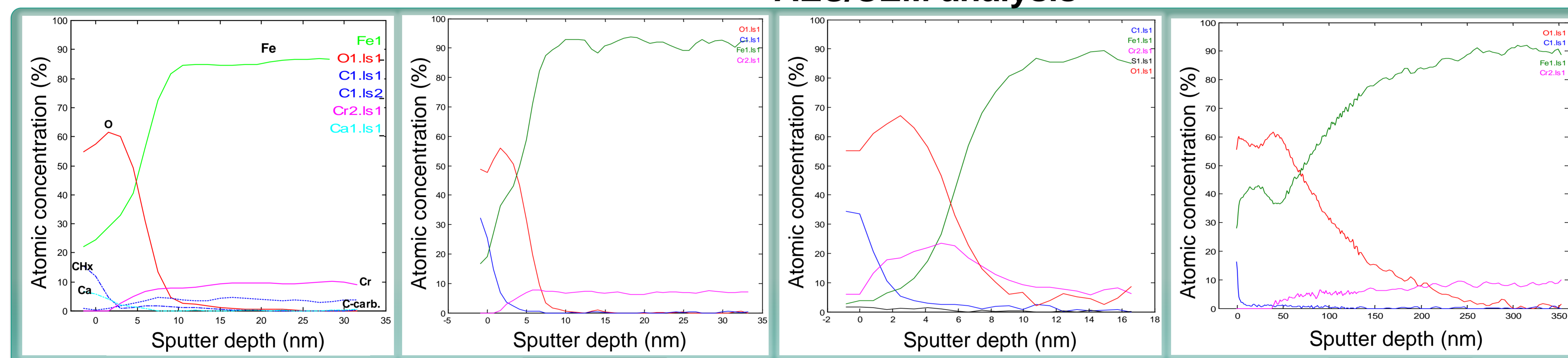
Sample appellation:
V/A-TTT-H

Heating conditions:

Temperature (T)	250 °C		350 °C		450 °C		550 °C	
Atmosphere:	A	V	A	V	A	V	A	V
- Air (A)								
- High Vacuum (V)								
Heating time (H)	-	1h-3h	-	1h-3h	-	1h-3h	1h-3h	1h-3h

Sample analyses

AES/SEM analysis

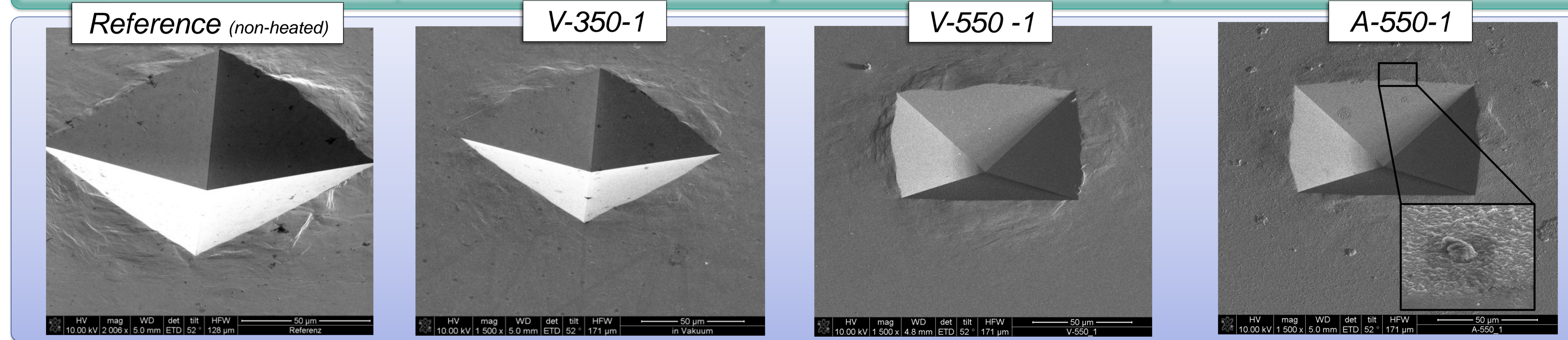


-Fe₂O₃ and Cr₂O₃ layers (thinner than 8 nm) stable up to 550°C in vacuum atmosphere (HV)

-Growth of Fe₂O₃ layer (thicker than 250 nm) for samples heated at 550°C in air-atmosphere

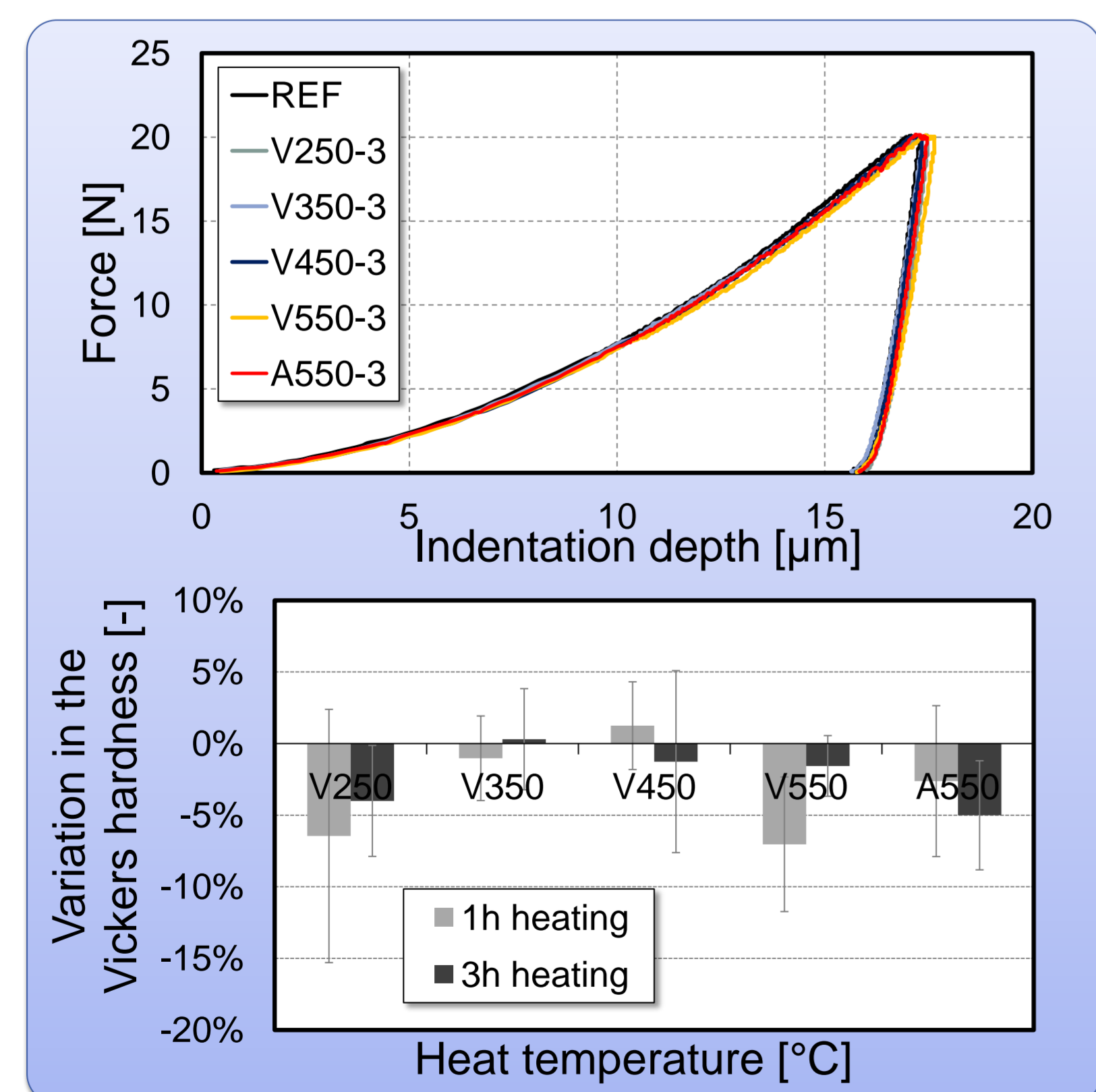
- Aspect of the polished surface remains stable for samples heated up to 550°C in HV atmosphere

- Porous and non homogenous surface observed, oxide particles visible for samples heated at 550°C in air atmosphere



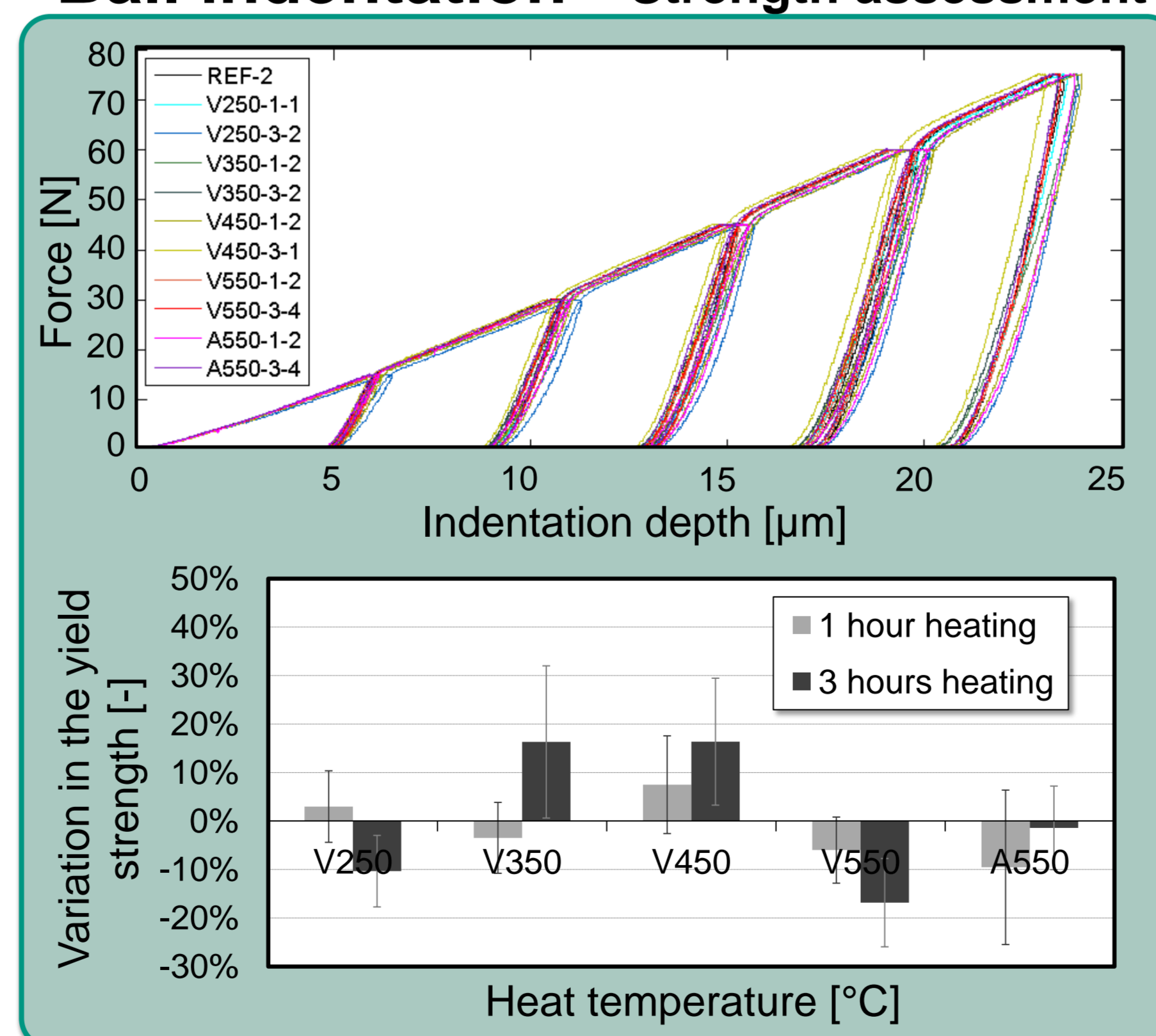
Sample testing

Vickers hardness test



- Discrepancy up to 7% between the average hardness of each heated samples
- No clear dependency to the temperature

Ball indentation – Strength assessment



- Discrepancy between all indentation curves, and assessed strengths lower than 6% and 17% resp.
- No clear dependency to the temperature

Conclusions

- The growth of the oxide layer observed at high temperature (550°C/3h) remains for both tested atmospheres at the nanometer scale
- The heating atmosphere plays a noticeable role in the growth of oxides, at 550°C/3h a HV atmosphere helps decreasing the formation of a superficial oxide layer by 97% for Eurofer97
- No clear trend to hardening was observed in the assessed mechanical properties that might result from the growth of a hard oxide layer formed by increasing the temperature
- Slight but not clearly defined changes in the mechanical properties are expected to occur during indenting at high temperature with the new instrumented indentation device

Literature

- [1] I. Sacksteder, and H.-C. Schneider, *Fus. Eng. Des.*, 2010
[2] N. Huber et al., *J. Nucl. Mater.*, 377, 2008, 352-358.

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