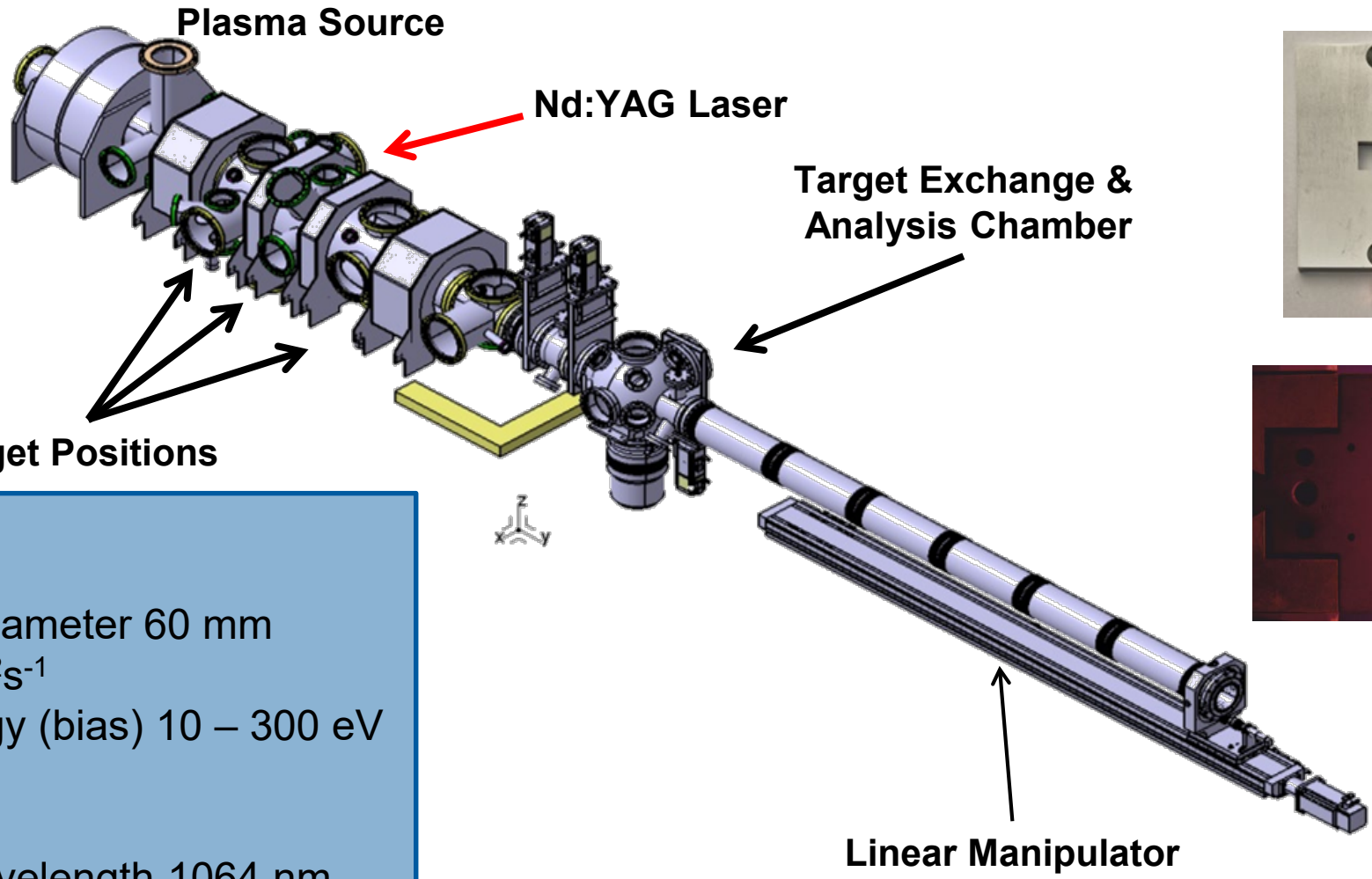
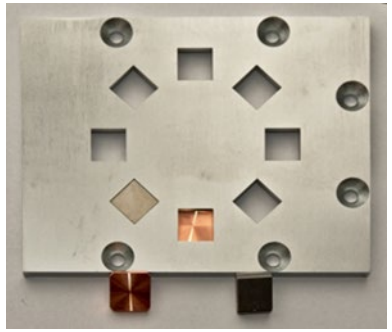
PWIE SPA midterm meeting 2022

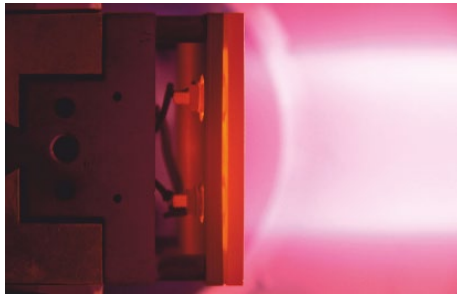
29th August 2022 I M. Wirtz et al.

Forschungszentrum Jülich GmbH, Institut für Energie- und Klimaforschung, 52425 Jülich, Germany

Linear plasma device PSI-2







Steady-state
- D, He, Ar plasma
- plasma column diameter 60 mm
- ion flux ≤ 10^{23} $m^{-2}s^{-1}$
- incident ion energy (bias) 10 – 300 eV

ELM-like heat pulse
- Nd:YAG laser wavelength 1064 nm
- laser energy 32 J

PSI-2 conditions for all experiments

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- absorbed power density 0.41 GW/m²
- base temperature of approximately 1000 °C
- pulse duration 0.5 ms; repetition rate 10 Hz; 10^5 pulses

- Deuterium / Helium (6 %) plasma
- particle energy 35 eV
- flux ~ 4 x 10^{21} $m^{-2}s^{-1}$; fluence ~ 4 x 10^{25} m^{-2}

PIM samples, High pulse number tests

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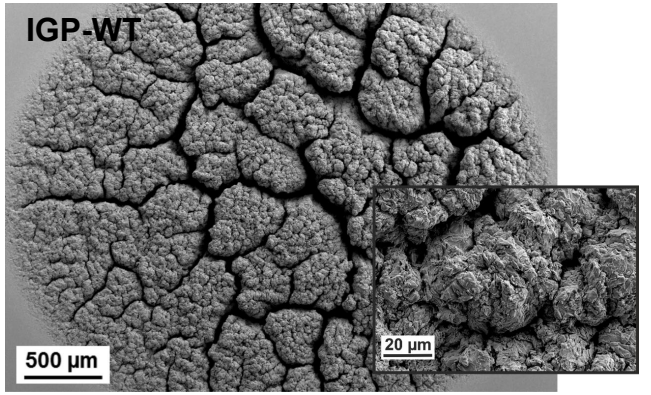
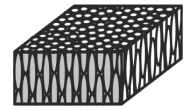
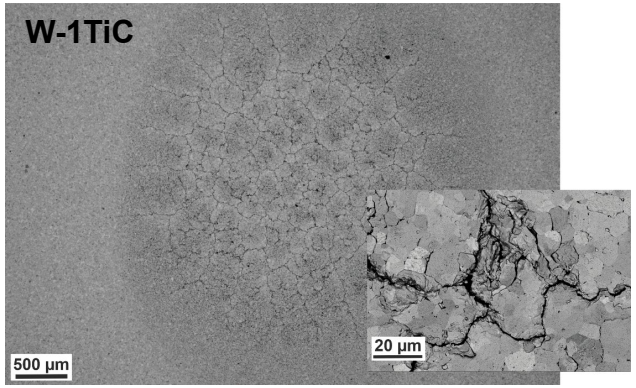
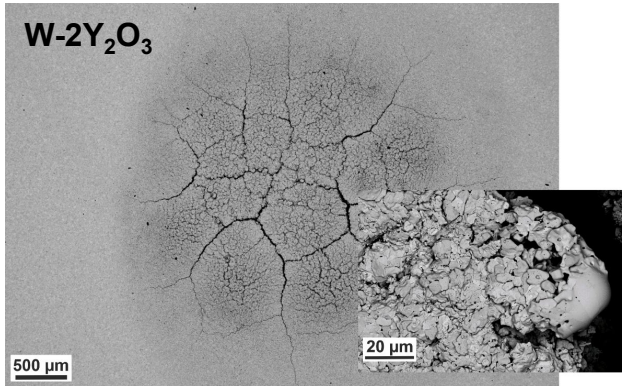
Samples produced at KIT

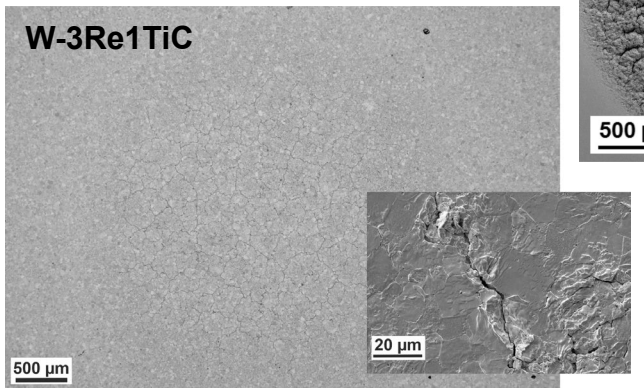


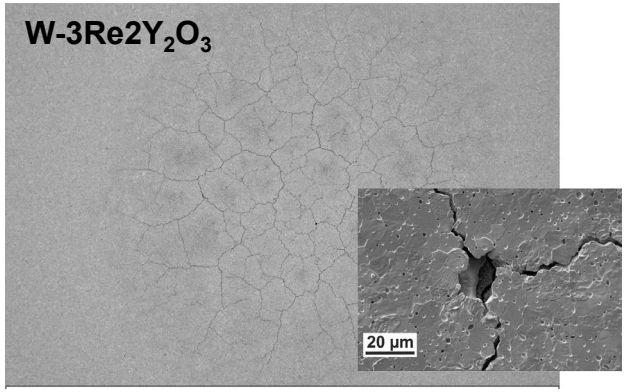


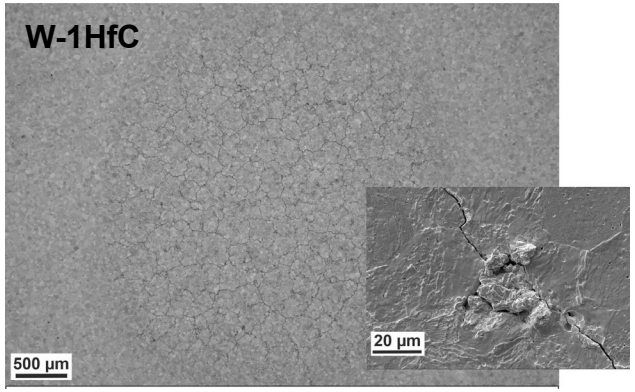
transversal

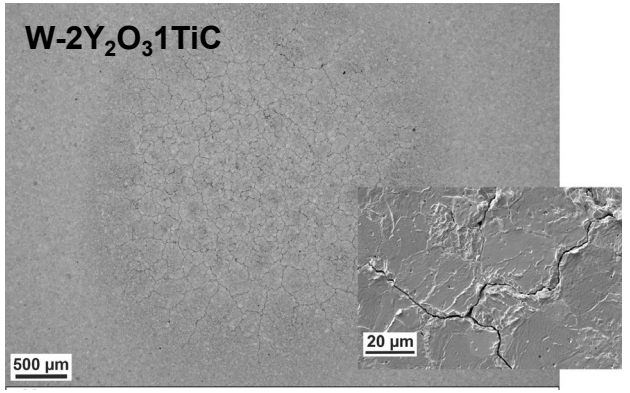












PIM samples, post mortem analysis

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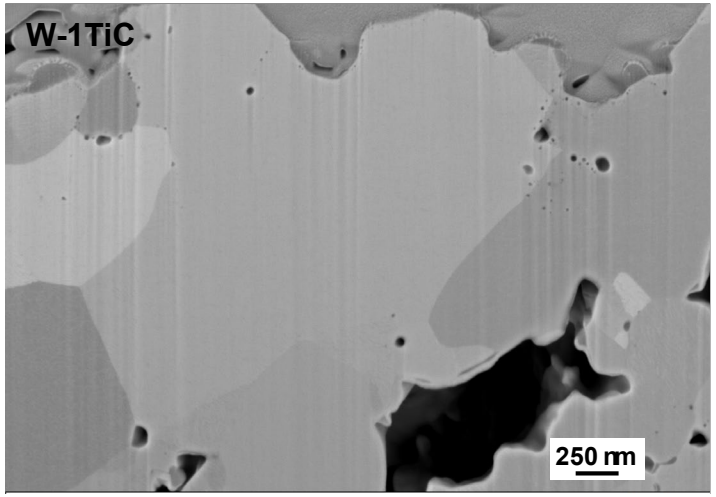
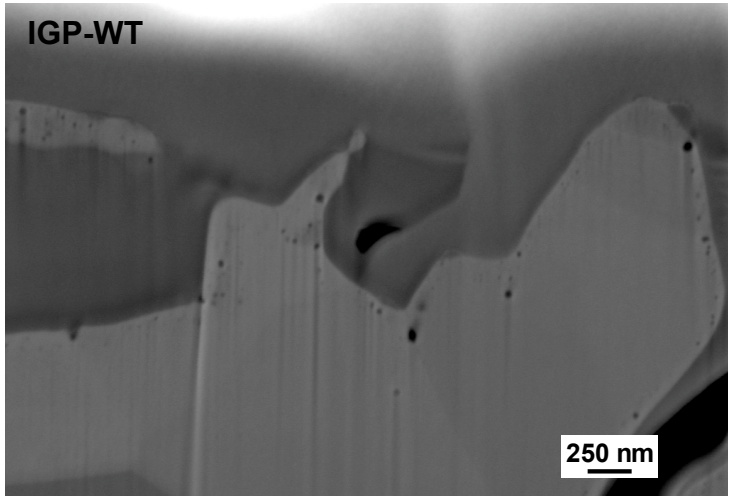
Mitglied der Helmholtz-Gemeinschaft

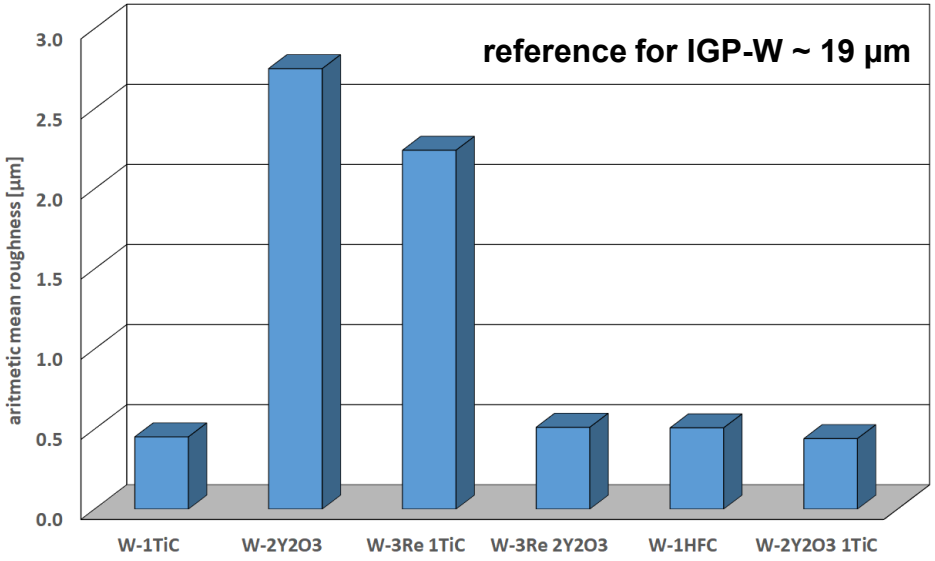
FIB cuts and bubble formation





Bubble formation is comparable for all tested materials.
Exemplarily shown for W-1TiC and IGP-WT.

Roughening



Summary and conclusions

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All PIM-W alloys show **comparable or better fatigue performance** to the as-received pure tungsten grade in terms of damage category and crack formation. However, more detailed investigation of the induced damages indicates that especially surface modifications like **roughening due to plastic deformation and the particle induced nanostructures are less severe/pronounced** for the PIM-W than for the reference pure tungsten grade.

Based on these results, PIM-W alloys represent a **very promising alternative material** to commercially available pure tungsten grades. The fatigue performance could be even further improved by an optimization of the microstructure via the manufacturing process parameters, i.e. used powders and thermal treatments.