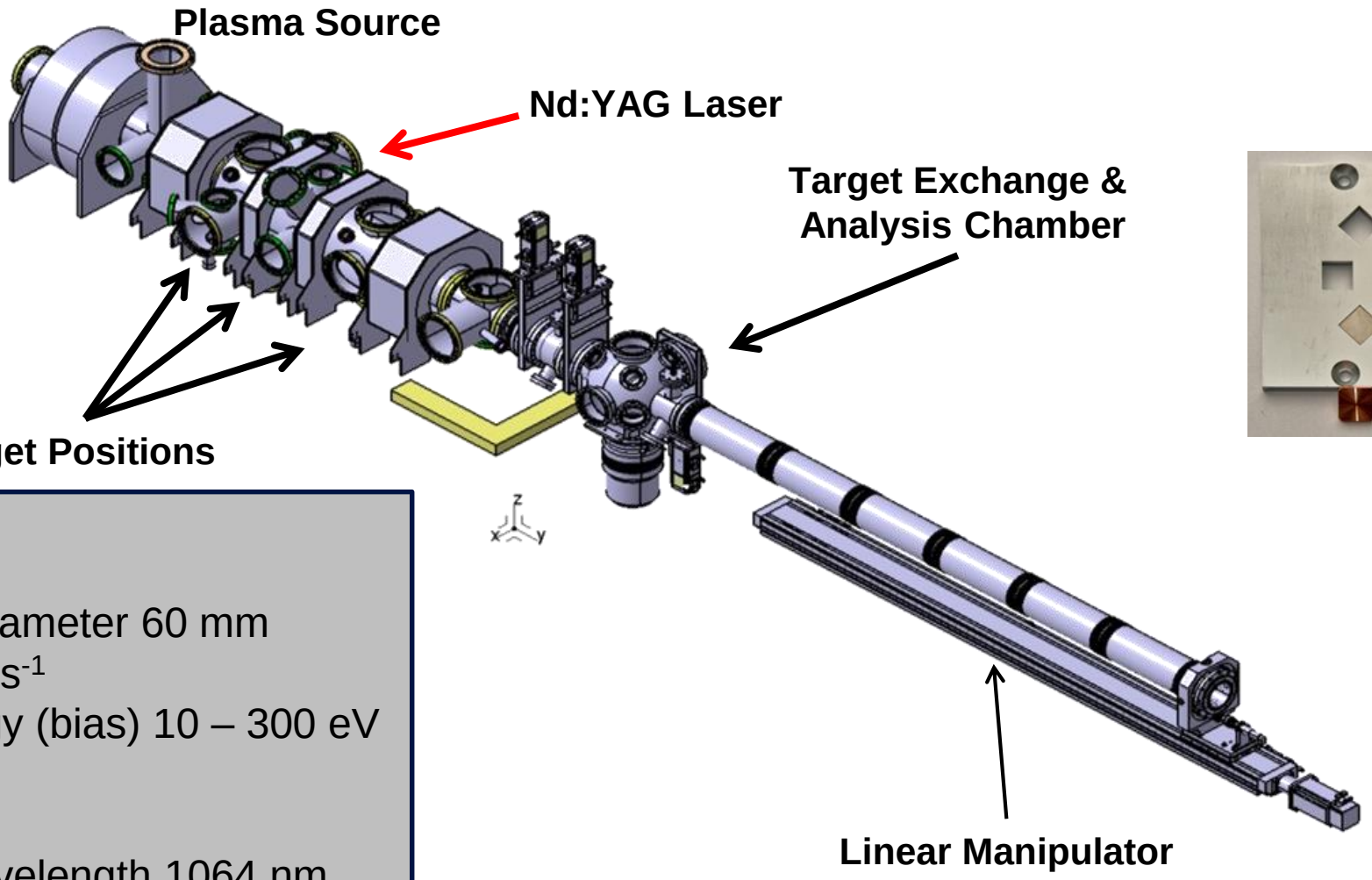
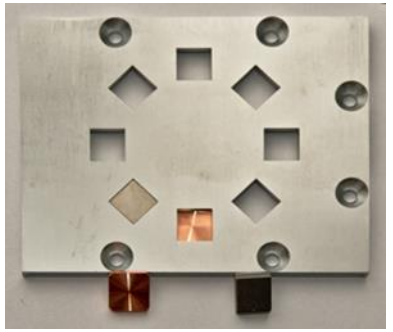
PWIE SPA midterm meeting 2021

15th September 2021 I M. Wirtz et al.

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

Linear plasma device PSI-2





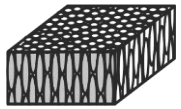
Steady-state
- D, He, Ar plasma
- plasma column diameter 60 mm
- ion flux ≤ 10^{23} $m^{-2}s^{-1}$
- incident ion energy (bias) 10 – 300 eV

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

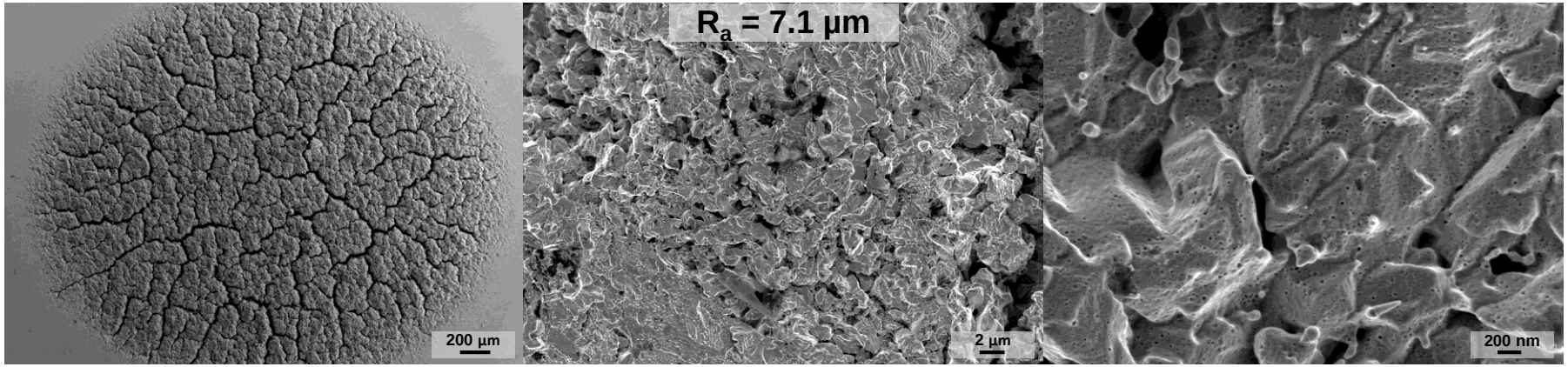
PSI-2 conditions for all experiments

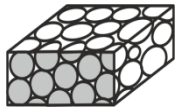
- **Base temperature of approximately 700 °C**
- **Deuterium / Helium (6 %) plasma**
- **0.5 ms laser pulses with a frequency of 10-25 Hz**

High pulse number tests, synergistic effects

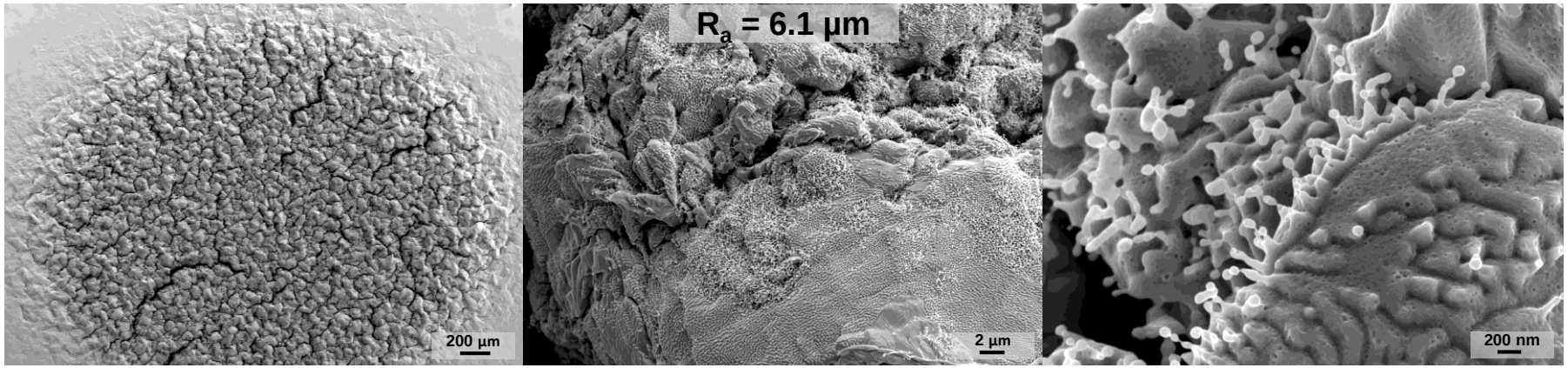


transversal





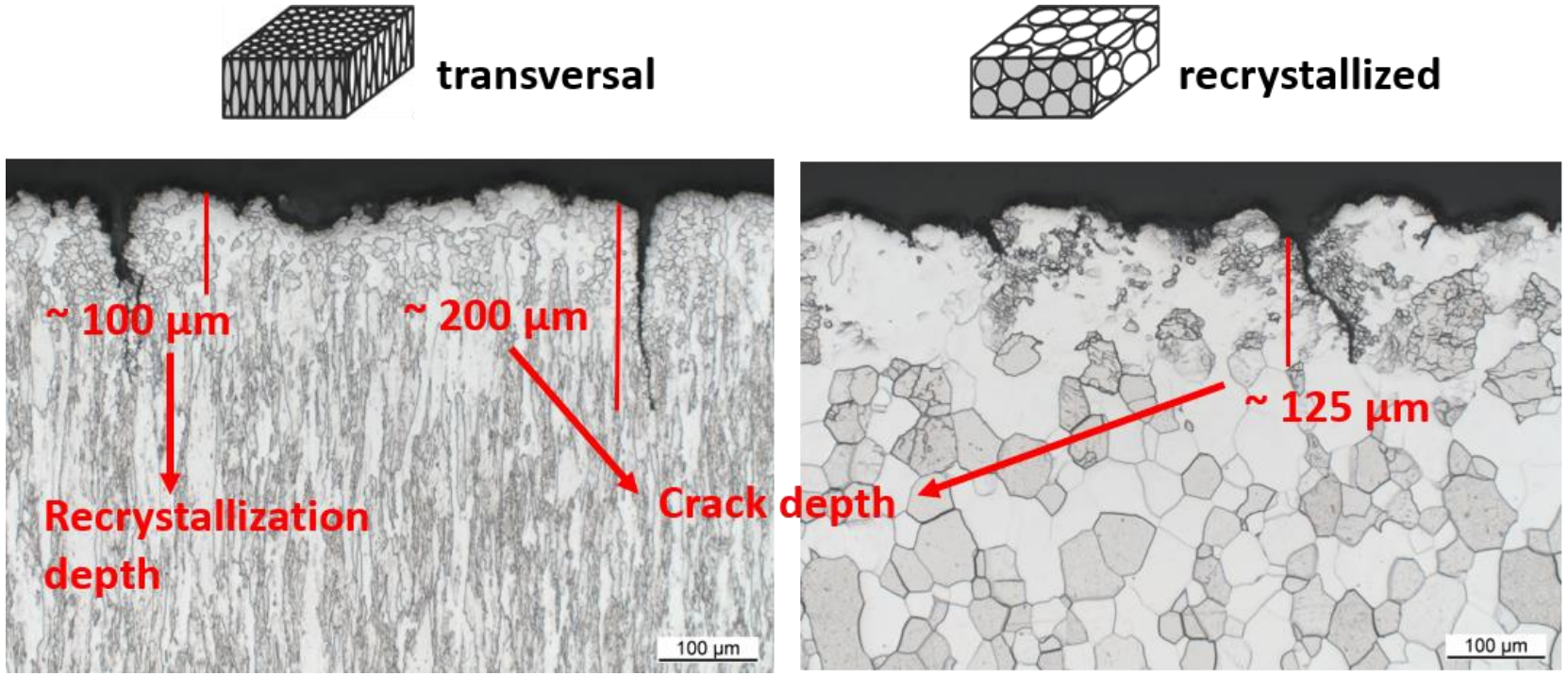
recrystallized



10^6 pulses, 25 Hz freq.
Power dens. = 0.2 GWm^{-2}

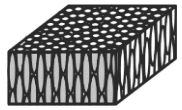
Flux = ~ 3.8·10^{21} m^{-2}s^{-1}
Fluence = ~ 2·10^{26} m^{-2}

High pulse number tests, cross-sections



10^6 pulses, 25 Hz freq.
Power dens. = 0.2 GWm^{-2}
Flux = ~ $3.8 \cdot 10^{21}$ $m^{-2}s^{-1}$
Fluence = ~ $2 \cdot 10^{26}$ m^{-2}

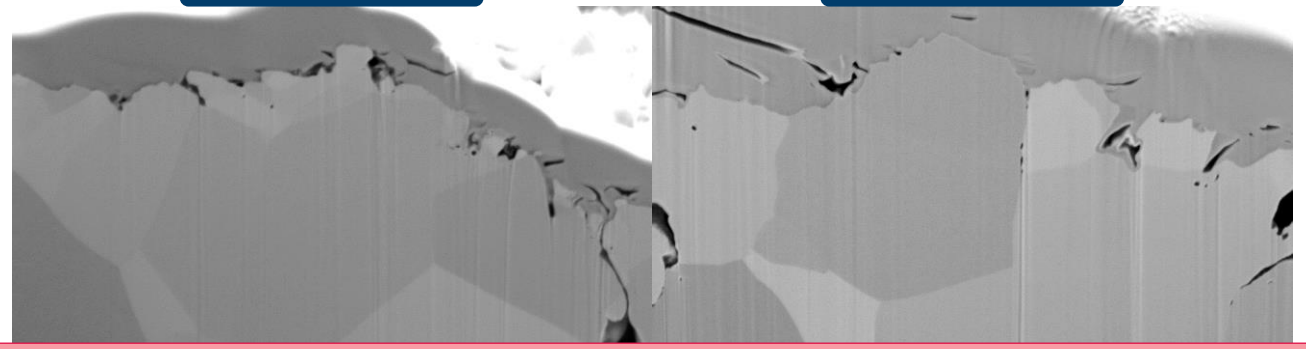
FIB – bubble formation



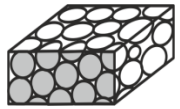
transversal

With plasma

Without plasma



Insignificant bubble formation, bubble formation seems to be accelerated by temperature spikes during transient thermal events



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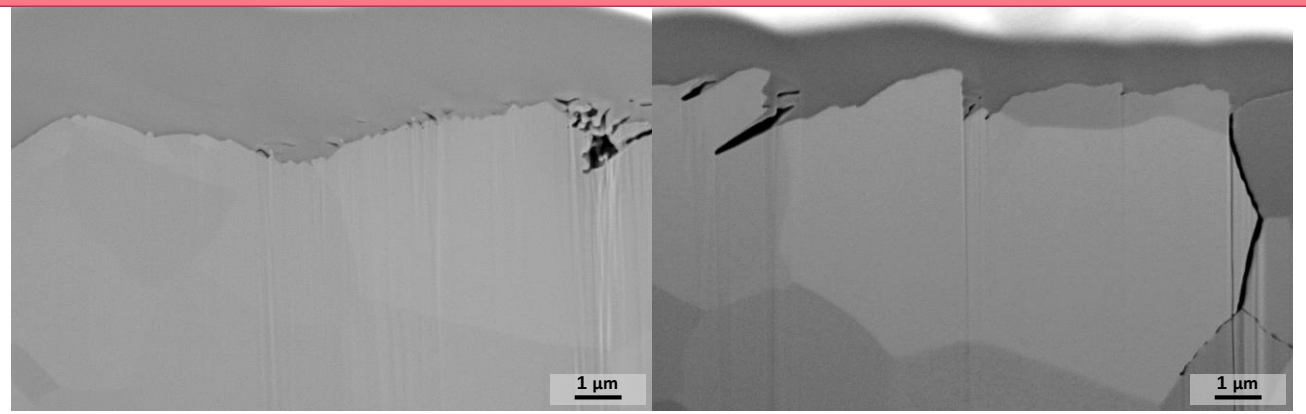
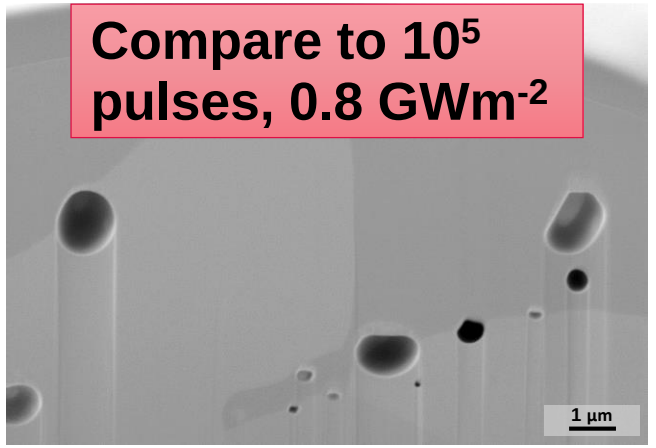
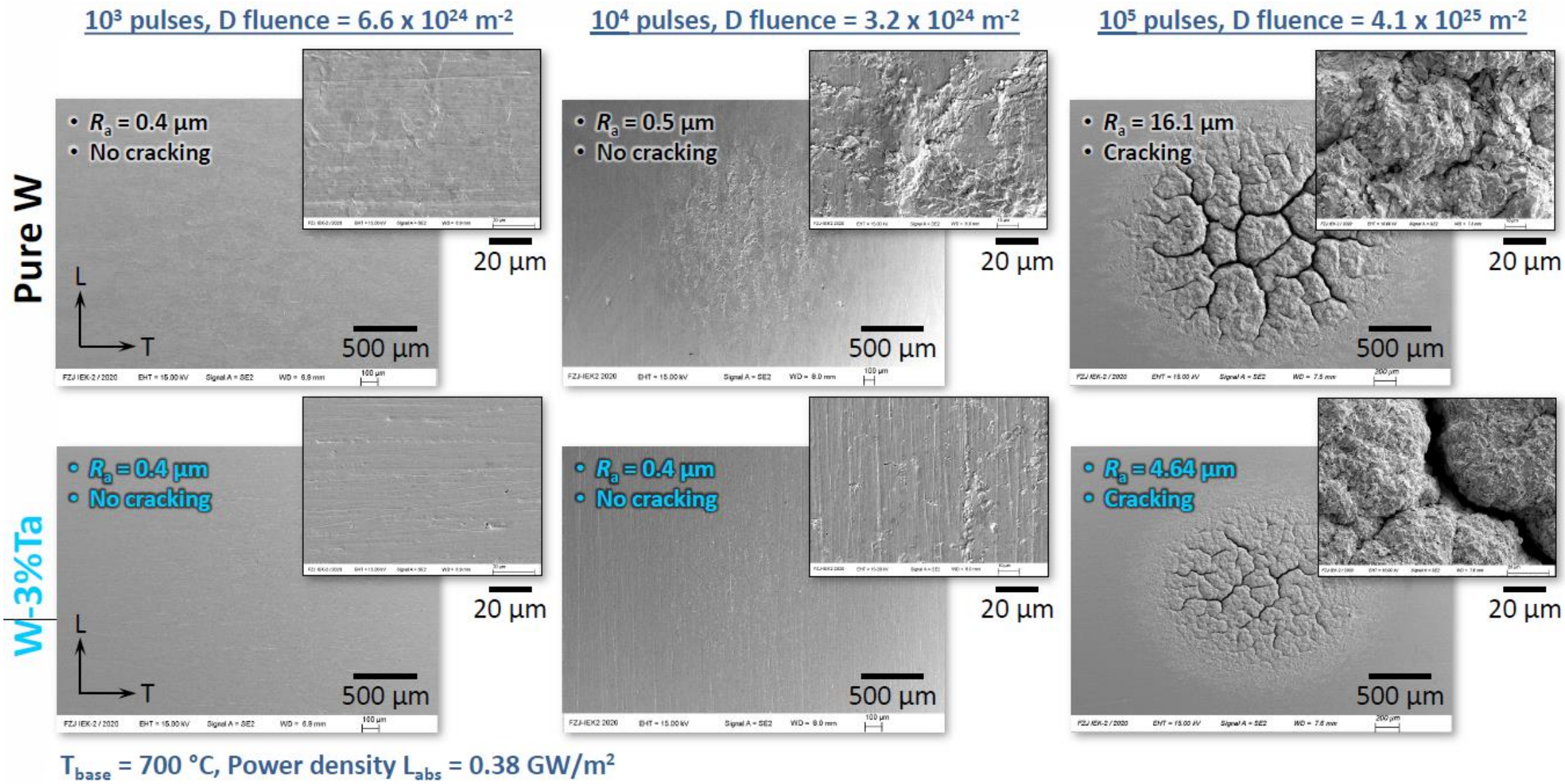




Flux = ~ $3.8 \cdot 10^{21}$ m^{-2}s^{-1}
Fluence = ~ $2 \cdot 10^{26}$ m^{-2}
Pulses = 10^6
Pulse freq. = 25 Hz
Power dens. = 0.2 GWm^{-2}

Thermal Shock behavior of W-Ta alloy



Summary and conclusions

- additional H/He plasma leads to an fast accumulation of damage (roughening due to plastic deformation)
  - ➢ significant changes of the microstructure below the laser spot
  - ➢ bubble formation is influence/accelerated by thermal shocks/temperature increase
- input from the MAT/PRD HHFM program:
  - ➢ WTa alloys show better thermal shock performance than pure tungsten (manufacturing process are the same)