WP PWIE SPA4 (2022): KIPT
D05: Influence of plasma pre irradiation with heat loads near surface recrystallization on surface damaging with heat loads above the melting threshold

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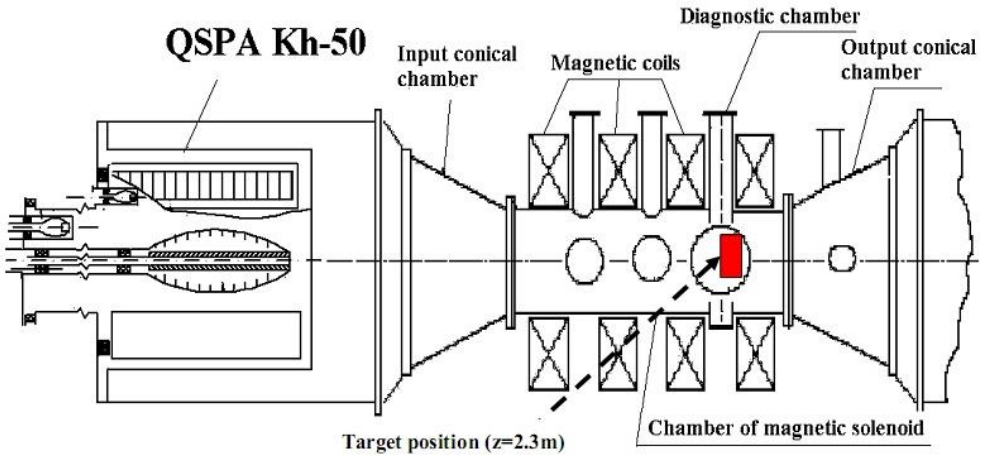
PWIE-SP A.A4.T-T002: High Temperature performance of Armour Materials: Recrystallization and Melting (2022)						
ID	Title	RU	Del. Owner	PM 50%	QSPA	
					PM 40%	Eq./OGS 40%
PWIE-SP A.A4.T-T002-D004	Influence of plasma pre irradiation with heat loads near surface recrystallization on surface damaging with heat loads above the melting threshold (KIPT)	KIPT	Igor Garkusha	15	6.99	5 days

Tasks planed for 2022:

- Tungsten material damaging by QSPA pulses under the plasma loads causing a pronounced surface melting
- Influence of plasma heat loads resulting in surface recrystallization to the melting threshold changes

SPA4: Experimental facilities: QSPA Kh-50



Diagnostics

- ❖Calorimetry
- ❖Optical emission spectroscopy
- ❖High-speed digital camera PCO AG

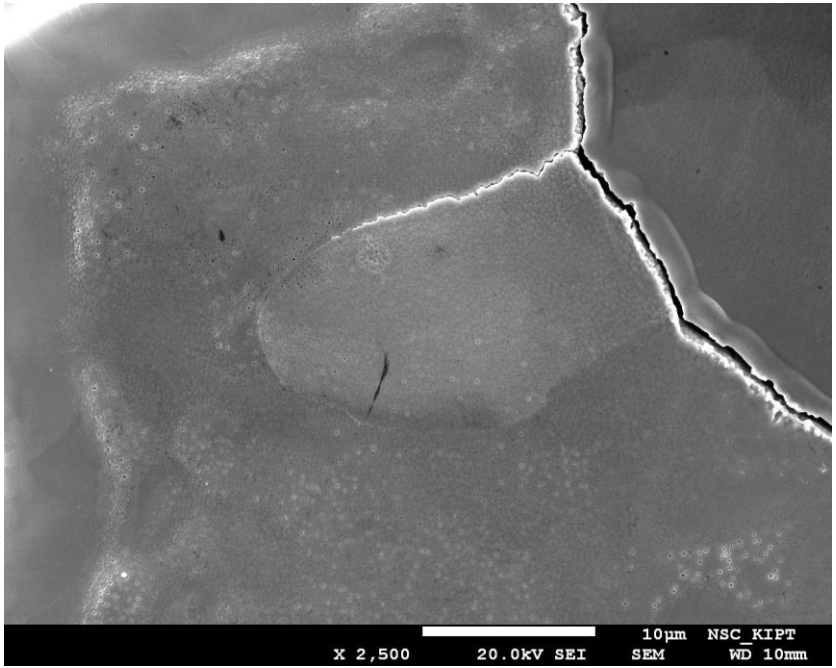
Parameters of QSPA Kh-50 plasma streams

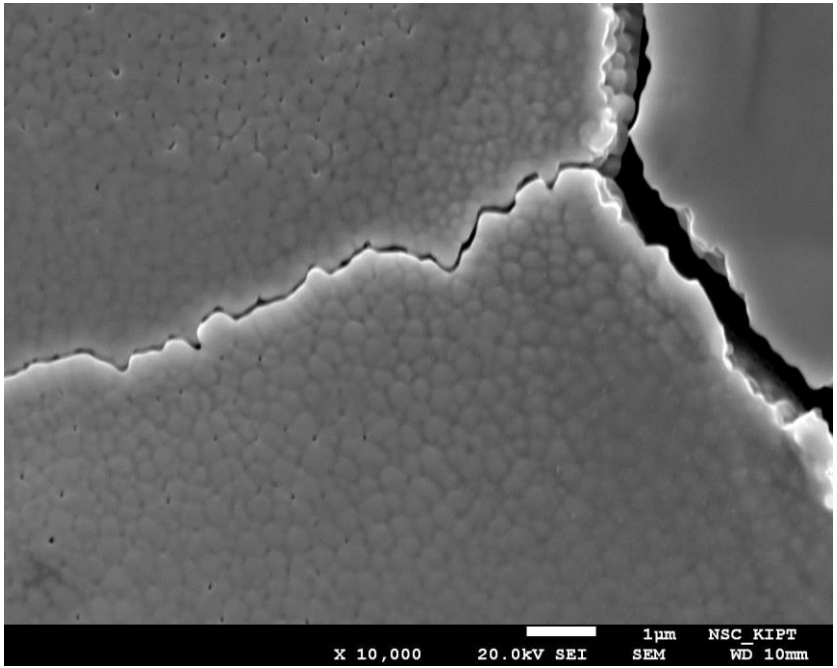
Plasma energy density, MJ/m^2	2.0
Plasma pressure, MPa	0.32
Plasma pulse duration, ms	0.25
Heat load on the leading edge, MJ/m^2	0.9
Heat load on the center of sample surface, MJ/m^2	0.6
Angle inclination, degree	30
Plasma stream diameter (cm)	18
Impact energy of ions (keV)	0.4

V A Makhlai et al *2020 Phys. Scr. T171, 014047*
V.A. Makhlai et. al. 2021 Phys. Scr. 96, 124043

- Tungsten damaging in QSPA under plasma loads which caused a pronounced surface melting.
- Characterization of dust in QSPA experiments. Stick effects at the surface.

Sp A.4:Surface modification of recrystallized (R) sample

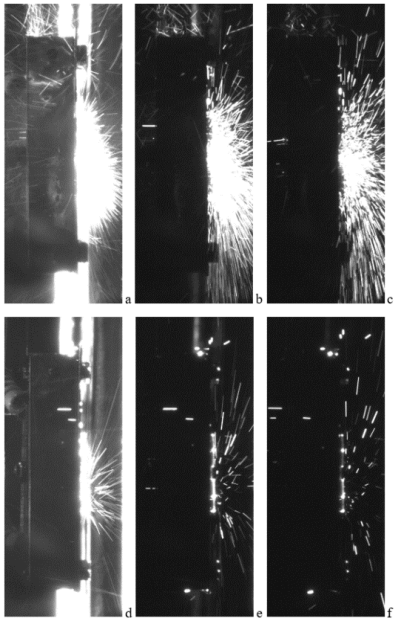


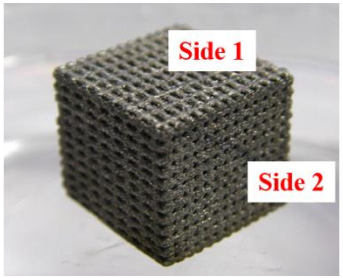


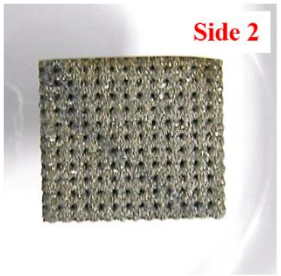
- Re-solidified layer
- Inter granular cracks with width up to µm
- Fine cellular structure of the surface layer were formed at heat load above melting threshold
- Typical cell size of 150…250 nm

Sp A.4: The particles ejection during PSI with the Advanced Materials

Latticing AM W/WTa samples exposed within QSPA Kh-50



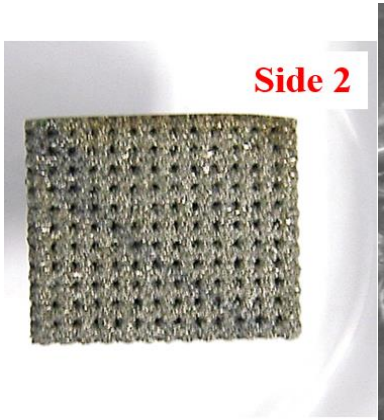


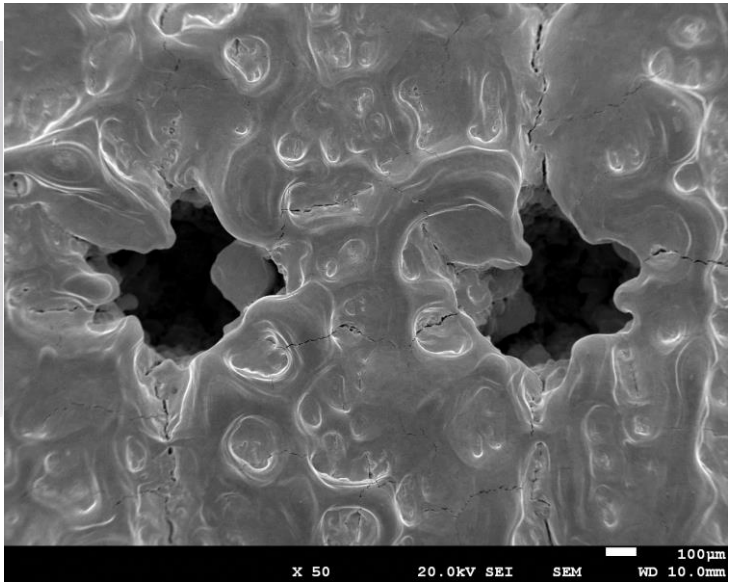


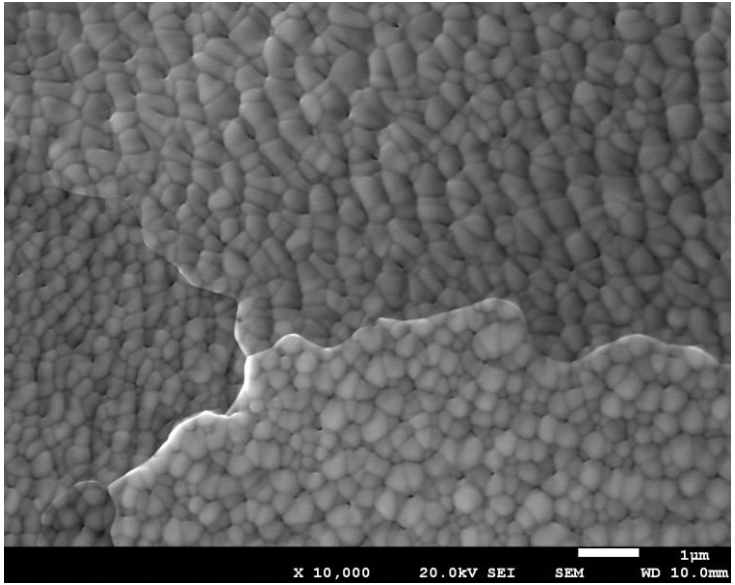
Large number of ejected particles after first plasma impact could be due to removal of weakly bounded fragments from the surface.
Number of ejected particles decreased with increasing number of plasma pulses.
It should be tested under different loadings and large number of plasma pulses

Images of PSI during first irradiation (energy density of incoming plasma 1.8 MJ/m^2) after 1st (top line) and 5th (bottom line) pulses corresponding to 1.2-2.4 (a, d) ms; 3.6-4.8 ms (b, e); 6.0-7.2 ms (c,f)) after the start of the plasma–surface interaction (texposure=1.2 ms).

Sp A.4:Surface modification of AM

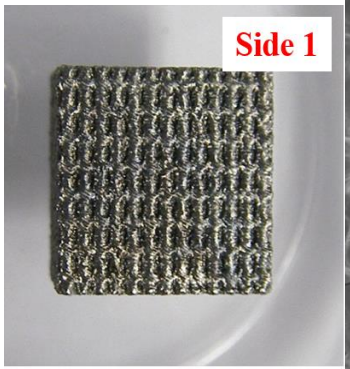


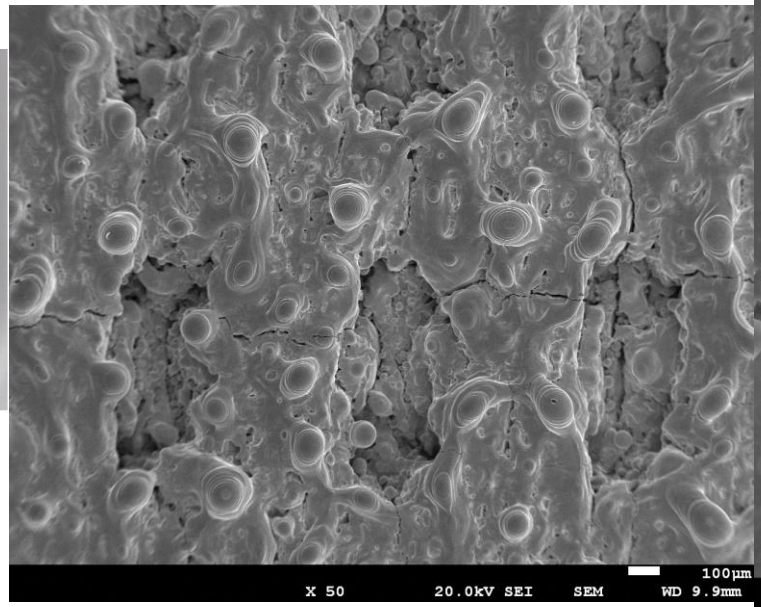


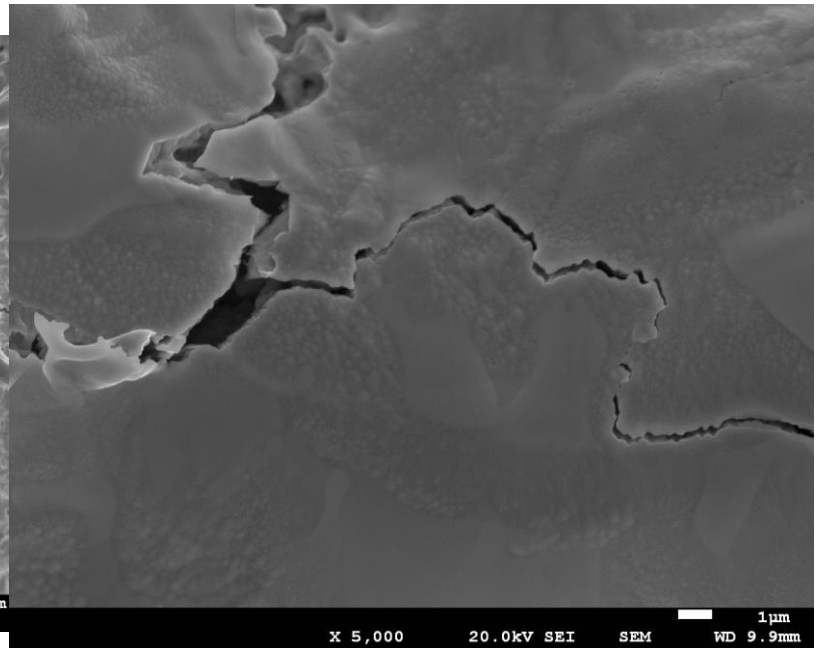


- Cracks, pores, balls are observed on the exposed surfaces
- Re-solidified layer
- Fine cellular structure of the surface layer in result of QSPA exposures
- Typical cell size of 150…250 nm

Sp A.4:Surface modification of AM







- Cracks, pores, balls are observed on the exposed surfaces
- Re-solidified layer
- Inter granular cracks with width up to several µm

SP A.4 : Summary

- Experiments will be shifted to 2023.
- Plasma heat loads which cause surface recrystallization and changes in microstructure and melting threshold
  - Tungsten material damaging in QSPA under giant ELMs/disruption-like loads which caused pronounced surface melting.
  - Contribution of plasma heat loads resulted in surface re-crystallization on degradation of melting threshold