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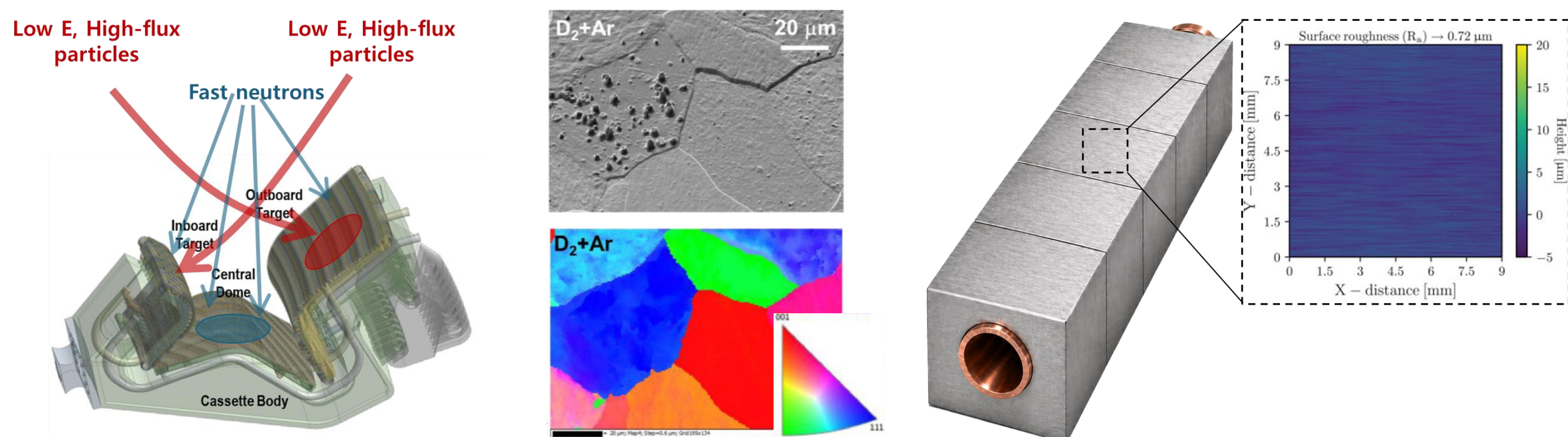
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## Motivation

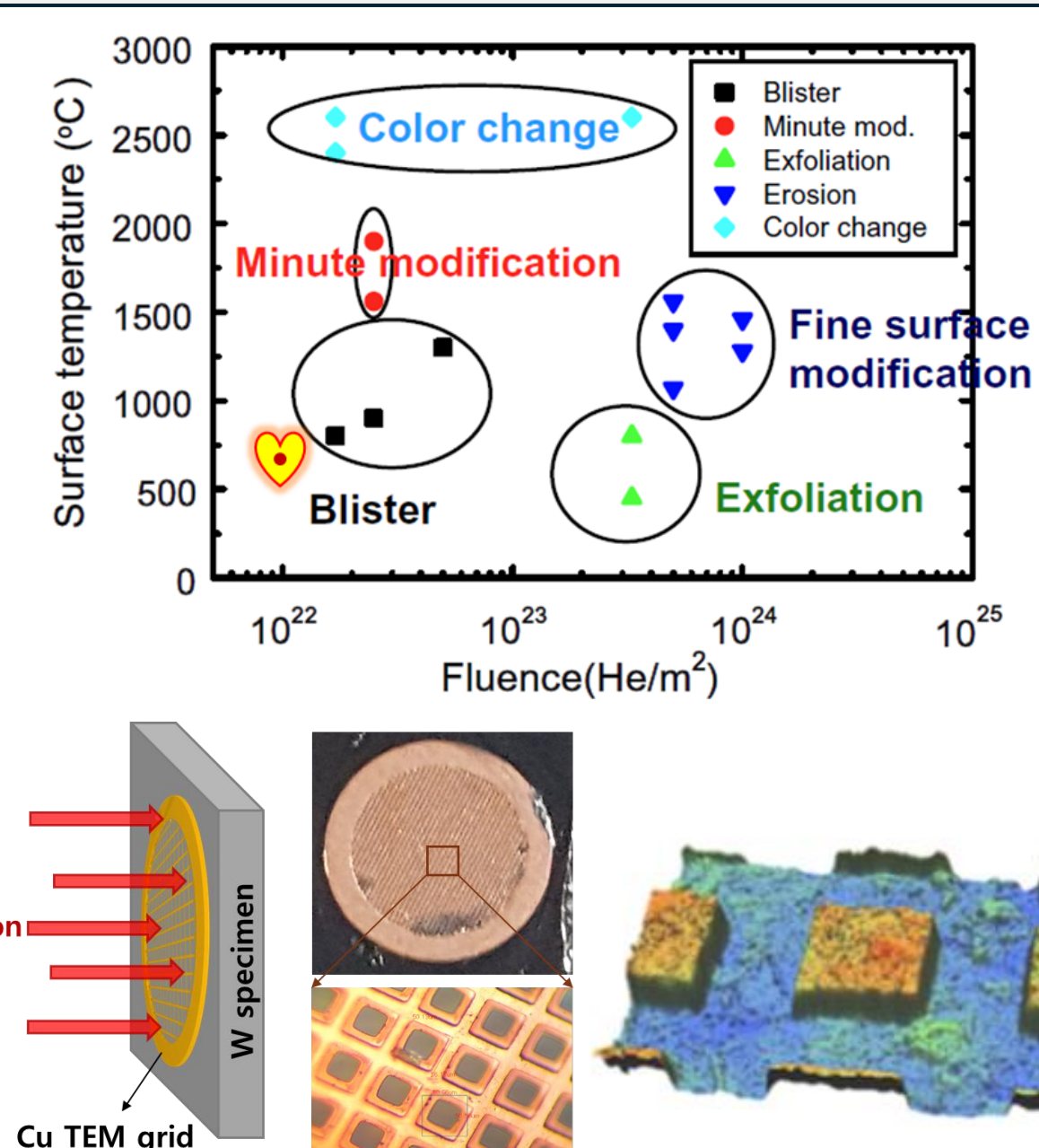
### Research questions

1. Orientation effect: D irradiation favors blistering on (111)-oriented W → Does He irradiation show the same orientation dependence?
2. Surface condition effect: Real W components contain polishing scratches and roughness → How do these surface features affect He blister nucleation?



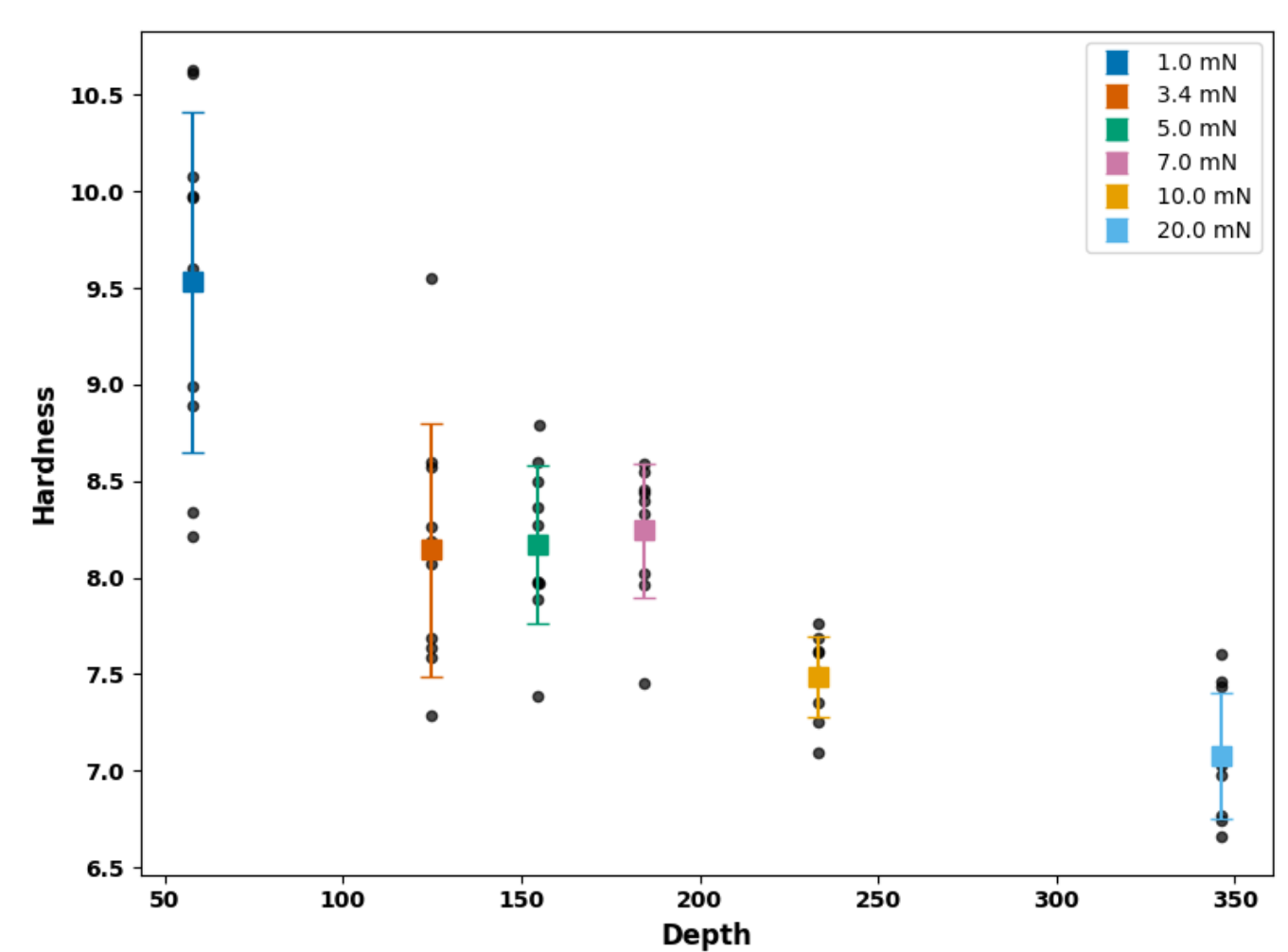
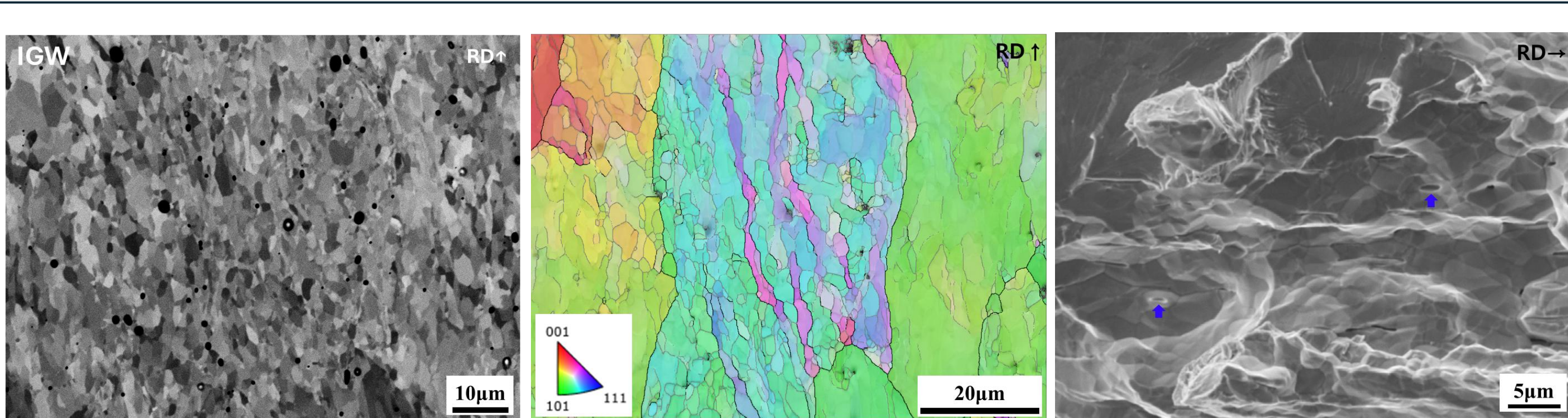
## Experimental Methods

- Material: ITER-grade W, post-sintering rolled plate
- Irradiation: 20 keV He,  $1 \times 10^{18}$  ions/cm<sup>2</sup>, 700 °C
- Analysis methods
  - Selective ion implantation using a TEM grid
  - Surface characterization by FE-SEM
  - Mechanical property measurement by nanoindentation
  - Crystallographic orientation analysis by EBSD
  - Surface morphology analysis by 3D laser microscopy
  - FIB analysis for cross-sectional microstructure investigation



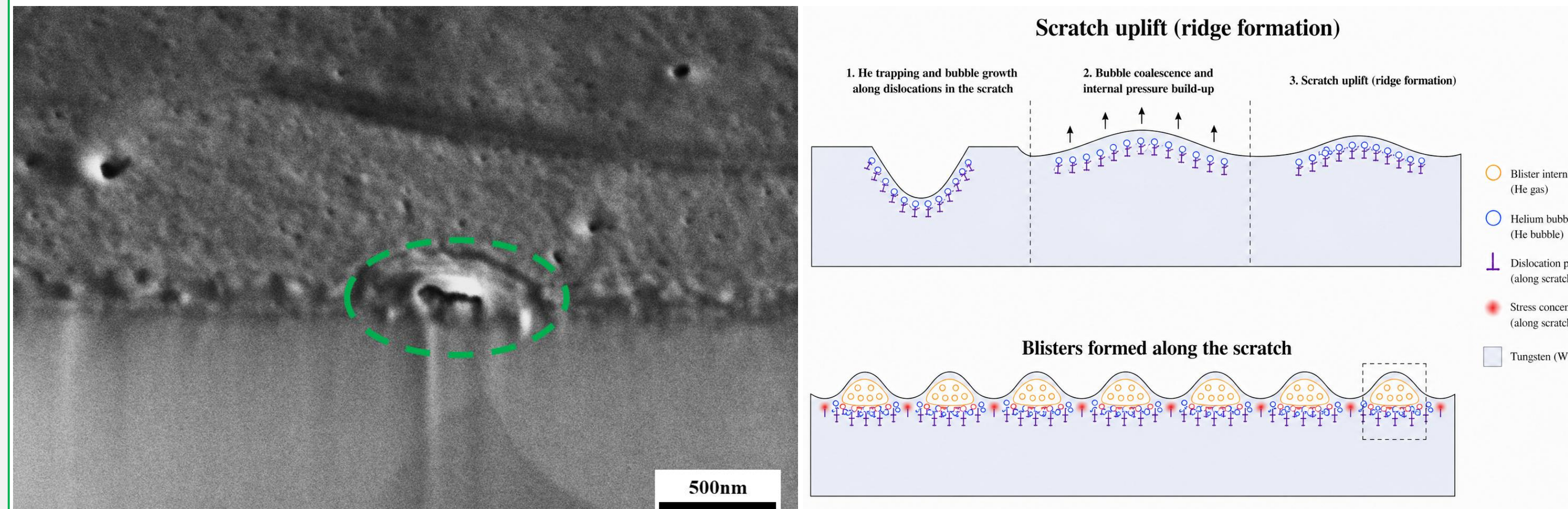
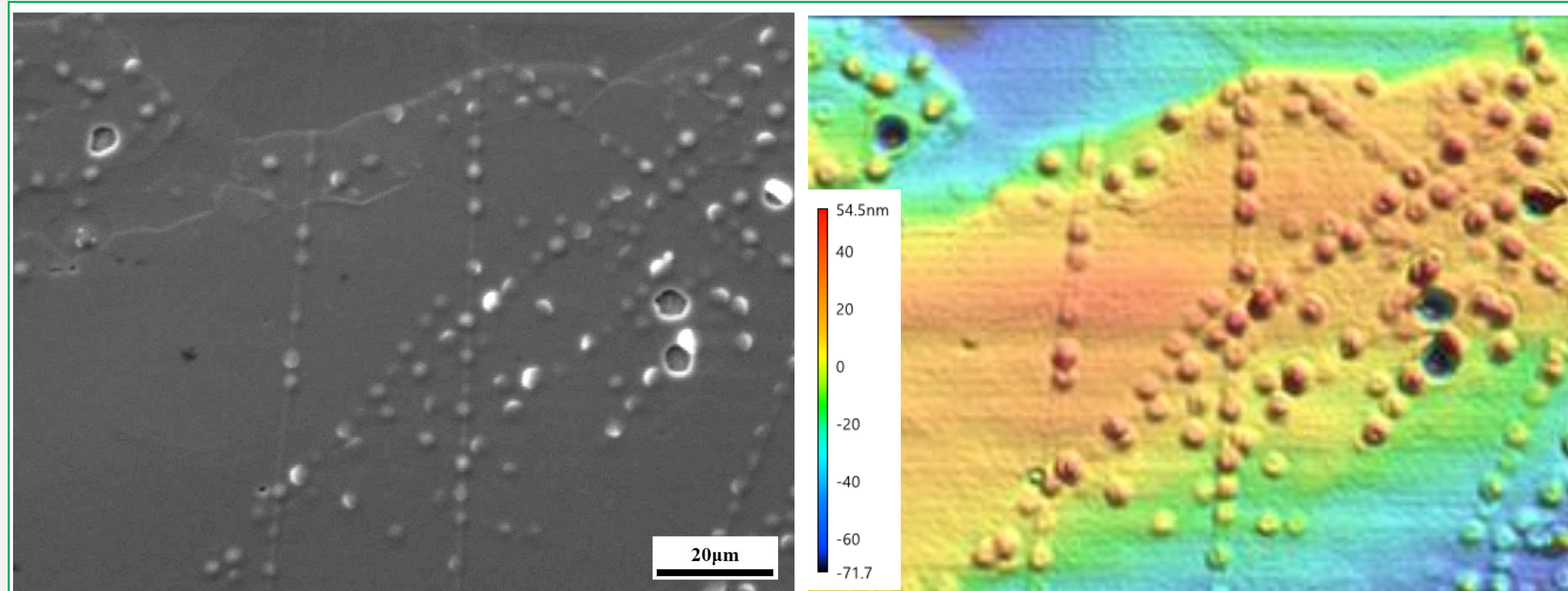
## Results & Discussion

### Initial Microstructure



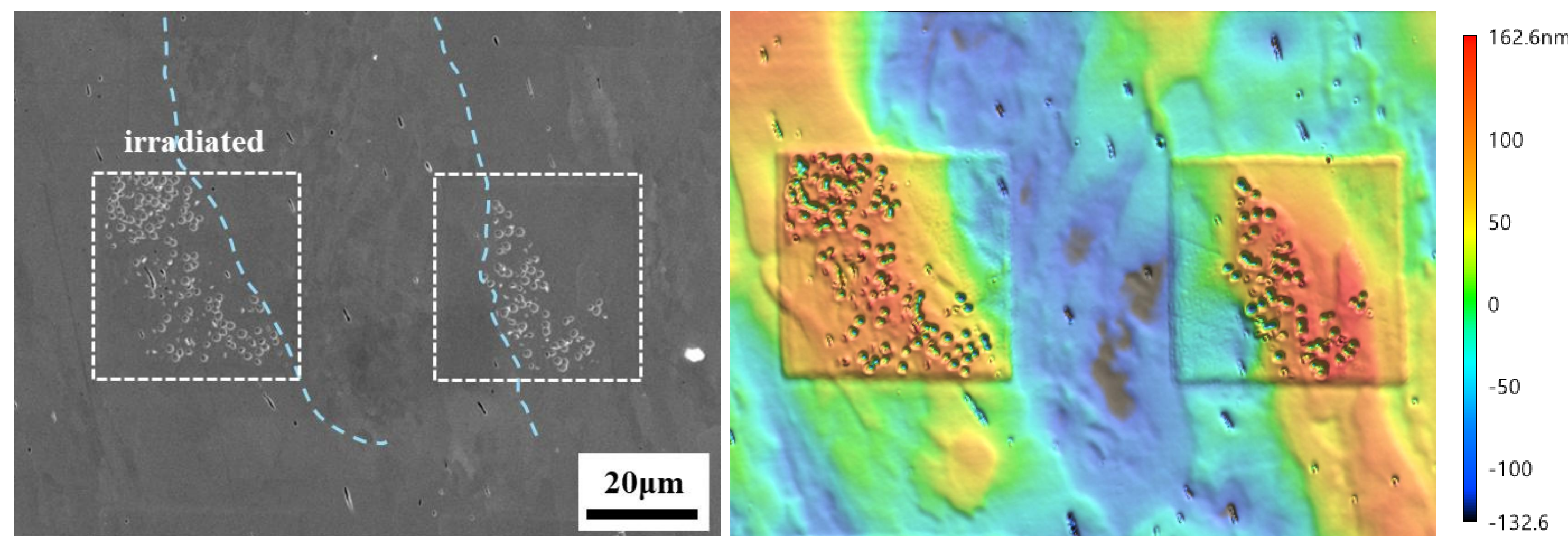
- Rolled W showed elongated band-shaped grains with fine sub-grains.
- EBSD revealed slight misorientation within grains.
- Fracture surfaces showed flattened pores and brittle river patterns.
- Nano-hardness decreased with indentation depth due to the indentation size effect.

### Scratch-line-induced Dome Formation



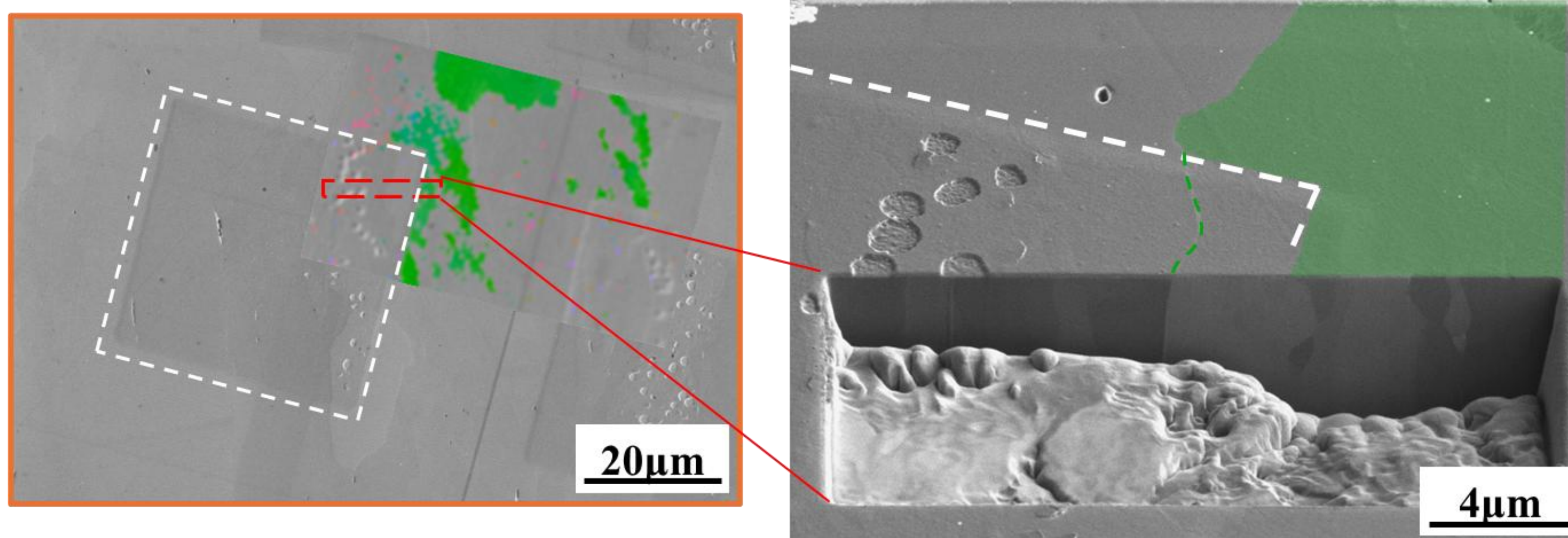
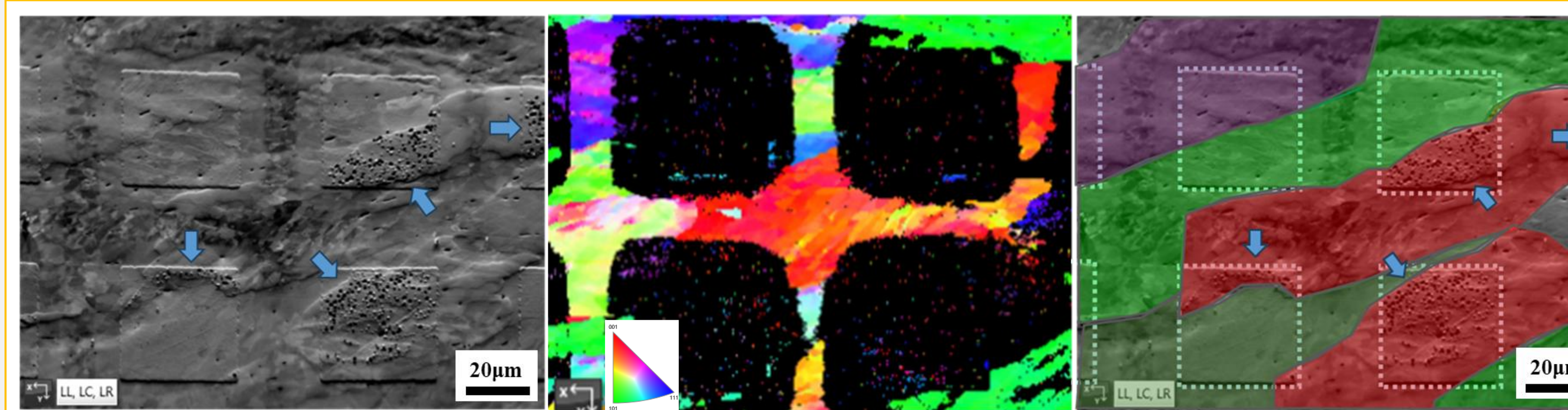
- Blisters were concentrated along polishing scratches.
- Scratches protruded after He irradiation.
- FIB confirmed cavities beneath scratch-associated blisters.
- Scratch-induced defects likely promote He trapping and blister nucleation.

### He-induced Surface Deformation and Hardening



- TEM-grid masking separated irradiated and unirradiated regions.
- Blisters and craters were concentrated in specific band-shaped grains.
- Large blisters likely ruptured into craters.
- He irradiation increased nano-hardness.

### Orientation-dependent Blistering Behavior



- Blisters were concentrated in the (001)-oriented band.
- Other orientations showed limited blistering.
- FIB revealed empty craters after surface-cap rupture.
- Orientation-dependent He bubble distribution will be examined by TEM/APT.

## Conclusions and Future Work

- He blistering in ITER-grade W was highly localized by crystallographic orientation and surface scratches.
- The (001)-oriented bands showed intensive blister/crater formation.
- Mechanical polishing scratches promoted local blister nucleation.
- FIB analysis suggests blister-to-crater transition by surface-cap rupture.
- TEM/APT analysis will be used to clarify orientation-dependent He bubble evolution.

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