

# STRUCTURE EVOLUTION OF TUNGSTEN COATINGS EXPOSED TO PLASMA FLOW UNDER ITER ELM RELEVANT CONDITIONS

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## The problem under study

Tungsten and tungsten alloys are primary Plasma Facing Materials (PFM) for next-step fusion devices such as ITER and DEMO. Tungsten coatings on different substrates can be a less expensive alternative to bulk tungsten for armoring the first wall in DEMO. Therefore, the most crucial is the problem of stability of the tungsten coatings under cyclic plasma loadings at current failures and boundary localized modes.

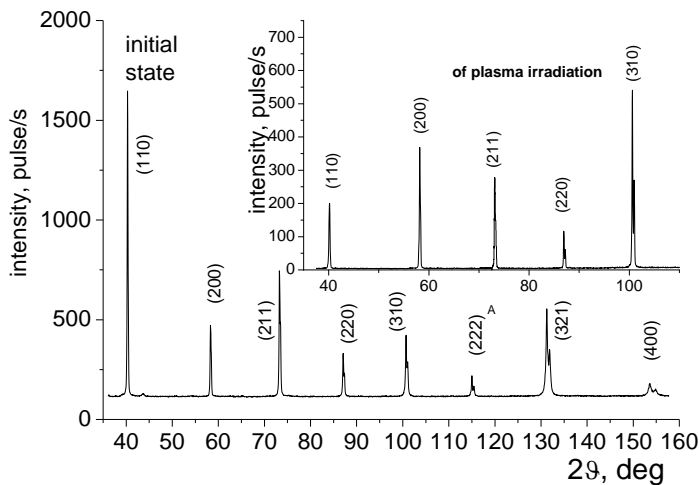
## Samples and research methods

Structure, substructure, and stress state of tungsten coatings on bulk steel surfaces were studied in the initial state and after irradiation. On the copper substrate, the coating was deposited by plasma sputtering method, while on the steel – by vacuum-arc sputtering. X-ray diffraction (XRD) has been used;  $\vartheta/2\vartheta$  scans were performed using a monochromatic Cu- $K_{\alpha}$  radiation. Computer processing of the experimental diffraction patterns was carried out using the «New profile 3.5» software package.

## Irradiation conditions

The tungsten coatings were irradiated by hydrogen plasma using a quasi-stationary plasma accelerator QSPA Kh-50. The basic parameters of plasma flows were as following: particle energy to 400 eV, plasma maximum pressure 3.2 Bar. The surface plasma loads measured with a calorimeter were from 0.45 to 0.75 MJ/m<sup>2</sup>, i.e. between the tungsten cracking (0.3 MJ/m<sup>2</sup>) and evaporation (1.1 MJ/m<sup>2</sup>) thresholds. The plasma pulse shape was triangular with pulse duration of 0.25 ms.

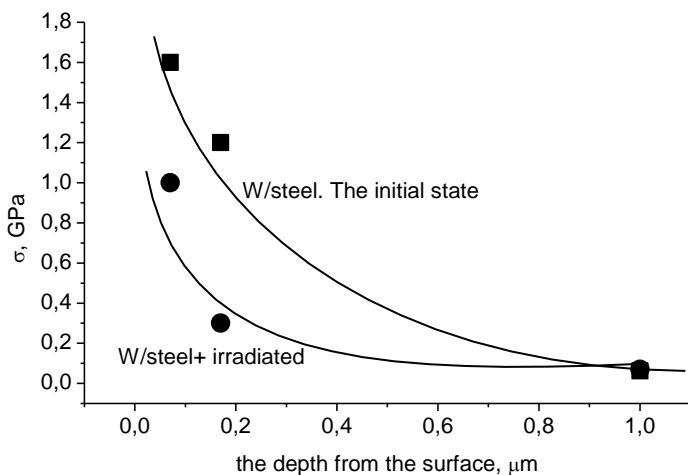
- ❖ No texture was observed in the coating in the initial state of the W/steel coating



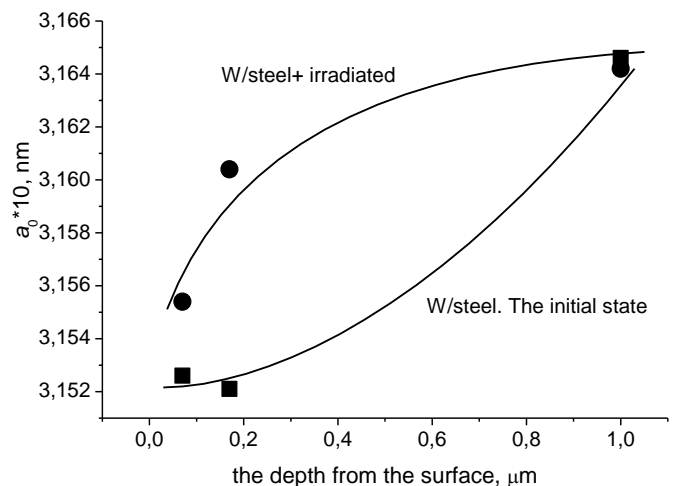
- ❖ As result of plasma irradiation, the texture with axis [100] normal to the surface appeared due to recrystallization of the affected material.

- ❖ Coherence length was 60 nm in the initial state, and 80 nm after irradiation.

- ❖ The initial average micro-strains about  $1.7 \cdot 10^{-3}$  have been completely annealed, and the initial dislocation density ( $9.2 \cdot 10 \text{ cm}^{-2}$ ) has been lowered twice in the exposed surface layer.



Stress change with the depth



Lattice parameter variation with the depth