Contribution ID: **941** Type: **Poster**

Microwrinkle Structure on Refractory Metal Surfaces irradiated by Noble Gas Plasma Species

Friday, 21 October 2016 14:00 (4h 45m)

In fusion reactor, the fusion output will be severely restricted by melting of divertor target plate made of W material. Therefore, the artificial impurities such as neon, argon, nitrogen would be injected into edge region to have a strong radiation to the whole plasma-facing surface to mitigate an overheating of a narrow divertor target surface area. Therefore, the divertor plasmas contain noble gas species, which have interactions with the divertor target surface. So-called "fuzz"formation [1, 2] is one of well-known phenomena. Another important surface modification, microwrinkle formation, has not yet been examined so far although the surface damage may be much influenced and would be triggered by this structure. The present paper clarified the structural formation experimentally, identified the formation mechanism, and concluded that the formation is not specific but very general phenomena in plasma-surface interactions.

Microwrinkle structures with the pitch of less than 100 nm up to 600 nm on refractory metals, like tungsten (W) and molybdenum (Mo) irradiated by noble gas ions, like neon (Ne) and helium (He), have been identified systematically for the first time. The wrinkle formation mechanism is clarified to be a buckling of surface hard layer supported by a soft elastic substrate [3] induced by a penetration of noble gas species from the irradiated surface. Microwrinkle forms on this structure under lateral compressive strain/stress fields coming from thermal constriction on the way to substrate cooling. Such process would be anticipated when the wall in fusion reactor is attacked by the heat pulses like ELMs and/or vertical displacement events, and it might be an initial stage of W surface damage.

Ne injection experiments into W [4] did not produce any fuzzy nanostructure on W. Recent molecular dynamic simulation on Ne implantation in W confirms the limitation of large bubble formation and the prevention of fiber-form nanostructure [5]. They did not touch upon wrinkle structure formation. However, Ne penetration into W lattice plays a role of pinning against geometrically necessary dislocation movement, bringing a surface hardness of W. The buckling process would occur during a cooling stage of substrate. At that period Ne atoms remain temporarily at the surface layer, maintaining a surface hardness of W although Ne atoms may go out from the surface on the way to cooling down to the room temperature, which was confirmed with TDS measurements. Such dynamic retention of Ne atoms associated by a thermal constriction strain would produce buckling.

References

[1] S. Takamura et al., Plasma Fusion Res. 1 (2006) 051.

[2] S. Takamura et al., Applied Surf. Sci. 356 (2015) 888.

[3] T. Ohzono and H. Manobe, J. Colloid Interface Sci. 368 (2012) 1.

[4] M. Yajima et al., Plasma Sci. Eng. 15 (2013) 282.

[5] M. Backman et al., Nucl. Fusion 56 (2016) 046008.

Paper Number

PDP-7

Country or International Organization

Japan

Primary author: Prof. TAKAMURA, Shuichi (Aichi Institute of Technology)

Presenter: Prof. TAKAMURA, Shuichi (Aichi Institute of Technology)

Session Classification: Poster 8

Track Classification: EXD - Magnetic Confinement Experiments: Plasma–material interactions; divertors; limiters; scrape-off layer (SOL)