Tungsten fuzz: deposition effects and influence to fusion devices

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Exposures to helium plasma may lead to the growth of fiberform nanostructures (FNs) [1], fuzz, on plasma facing components. Since the fuzz growth was identified, extensive investigations have been performed experimentally and numerically to reveal the growth condition, the mechanism, the effect of annealing and heat pulses, and the changes of various physical properties; however, the growth mechanism has yet to be fully understood, and there are still unknown effects such as synergistic depositon and impurity effects on helium plasma irradiation.

In this study, after reviewing the researches about fuzz and the impact of fuzz on fusion devices including the potential of arc ignition, we show recent findings about enhanced growths of nanotendril bundles (NTBs) under with small amount of impurity and millimeter-thick large scale FNs by small amount of auxiliary W deposition [2]. Under W deposition conditions, the growth process is no more difussion limited process, which is observed on conventional fuzz growth [3], but it increased exponentially in the initial phase to ~10 μm/s. Even when the incident ion energy is lower than 20-30 eV, which is the threshold energy for conventional fuzz growth, significant porous layer can be formed with deposition. One can say that the sputtering by impurity and deposition can be additional important effects to determine to conclude the growth rate of fuzz in fusion devices.

Further, based on the observation of above enhanced growth and crystal orientation analysis of straight FNs identified on rhenium etc. [4], we introduce an epitaxial crystal growth model to explain the growth process of FNs by He irradiation.

[1] S. Takamura *et al.* Plasma Fusion Research **1** (2006) 051.
[2] S. Kajita *et al.* Sci. Rep **8** (2018) 56; S. Kajita *et al.* Nucl. Fusion **58** (2018) 106002.
[3] M. Baldwin and R. P. Doerner, Nucl Fusion **48** (2008) 035001.
[4] S. Kajita *et al.* Acta Materialia 181 (2019) 342.