Investigationof deuterium and helium plasma irradiation effect on tungsten erosion

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Typicalsputtering is a phenomenon in which a tungsten atom is sputtered out bymomentum transfer. However, irradiation of deuterium and helium ions causemorphology deformation, that is, blister and fuzzy structure, through whichaccelerated erosion under threshold energy is observed. Each deformation iscaused by different mechanism, thus it is expected that there is synergeticeffect on erosion rate. Thisstudy deal with tungsten erosion rate in an environment that the both tungsten morphologydeformation can be formed by sequential and simultaneous irradiation ofdeuterium and helium ions. Alltungsten sample was prepared as a mirror surface. An electron cyclotronresonance deuterium and helium plasma was used for ion source where electrondensity was n_e =(4.5~6.5)x10^{17} m^{-3}, andelectron temperature was T_e=3~8 eV . For the deuterium and helium simultaneousirradiation condition, helium ion composition was measured by optical emissionspectroscopy of He I line. Also, the helium ion composition calculated byglobal model of ECR plasma that benchmarked D.Nishijima's model which containedionization, molecular assisted recombination, and molecular assisteddissociation with deuterium. The ion flux was calculated as product of Bohmvelocity and electron density which measured by Langmuir probe located 2cmabove the target. For the sequential process, pure D ion flux was F=6.0x$10^{21}$$m^{-2}$$s^{-1}$with 100eV target incident energy, and pure He flux was F=1.1x$10^{22}$$m^{-2}$$s^{-1}$with 40eV target incident energy. The fluence of deuterium was 1.14x$10^{25}$$m^{-2}$,the fluence of helium was 1.85x$10^{25}$$m^{-2}$.In simultaneous irradiation condition, deuterium and helium ion flux were F_D=6.38x$10^{21}$$m^{-2}$$s^{-1}$and F_{He}=1.53x$10^{21}$$m^{-2}$$s^{-1}$and total fluence was 1.45x$10^{25}$$m^{-2}$ .The ion incident energy was set at 40eV and 100eV. When helium ion irradiated on tungsten surface withblister, fuzzy structure was made on the blister and the sputtering yield hadno difference compared to case of fuzzy formed at mirror surface. In case ofdeuterium irradiated to tungsten fuzzy structure, the fuzzy structure was completelydisappeared and undetermined rough surface was formed without blister. Also,sputtering yield was increased 50% compared to blister formed at mirrorsurface. That means pre-generated fuzzy structure enhanced tungsten erosion bydeuterium. In the simultaneous irradiation condition, tungsten was eroded by linearsum of each ionic factor. Deuterium and helium act independently of tungstenerosion in the coexisting environment.