§67. Erosion of Plasma Facing Materials by Charge Exchange Neutrals

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CX-neutrals have large impacts on erosion of plasma facing materials (PFMs) and plasma density controlling through recycling and pumping in the wall. Authors have evaluated quantitatively energy distribution and flux of the CX-neutrals by examining microscopic damage in metals exposed to LHD hydrogen plasma. In the present work, a material probe experiment has been carried out in order to compare the CX-neutrals incident parameter in cases of gas-puff fueling and pellet injection.

Fig.1 shows a sample holder used in this experiment, which has a rotating shutter to distinguish each plasma. Pre-thinned vacuum-annealed disks of 3 mmϕ made of SUS316L, Cu, Mo and W were used as specimens. These specimens mounted on the material probe system were placed at the similar position of the first wall surface through the 4.5 L-port, and exposed to a couple of different hydrogen plasmas with gas-puff fueling and pellet injection (Fig.2). The total durations reached about 14s and 76s, respectively. After exposure, the microstructures of specimens were observed by means of transmission electron microscopy (TEM). In addition, irradiation experiments were carried out using TEM equipped with the ion gun.

Fig. 3 shows dark field images of the microstructure in the specimens exposed to each type of hydrogen plasmas. The radiation-induced dislocation loops with white contrasts were formed in these specimens. The threshold energies of hydrogen for knock-on damage in SUS316L, Cu, Mo and W are 370, 330, 850 and 2000eV, respectively. Accordingly, these defects indicate the existence of high energy incident particles in both cases. The number density of these defects in every specimen exposed to the plasma with pellet injections was larger than that in the gas-puff cases as shown in fig.3. Taking account of the difference of the duration time, the flux of high energy CX-neutrals, which could cause defects in Mo and W, was roughly estimated to be 1.5×10^{19} H/m^2s in both cases. In contrast with this high energy component, the flux of low energy CX-neutrals seems to have difference between the two cases, because the wide difference of defects density in Cu was observed beyond the difference of the duration times. This indicates that the CX-neutrals flux of low energy in the pellet injection cases is higher than that in the gas-puff cases, although the high energy components have nearly equivalent flux. Future work is required for detail analysis of the CX-neutrals incident parameter.

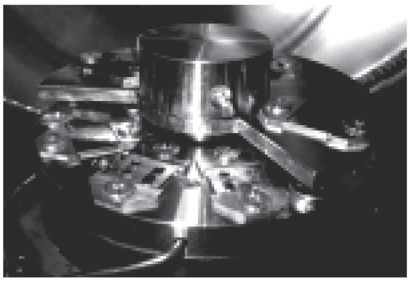

Fig. 1 The sample holder with a rotating shutter.

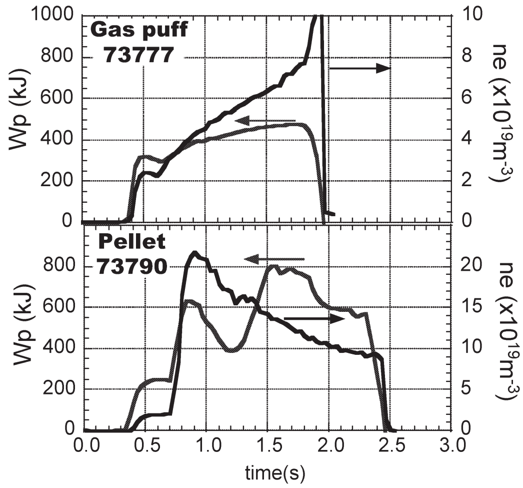

Fig. 2 Time evolutions of the stored energy (W_p) and electron density (n_e) in the plasmas with gas puff fueling and pellet injection.

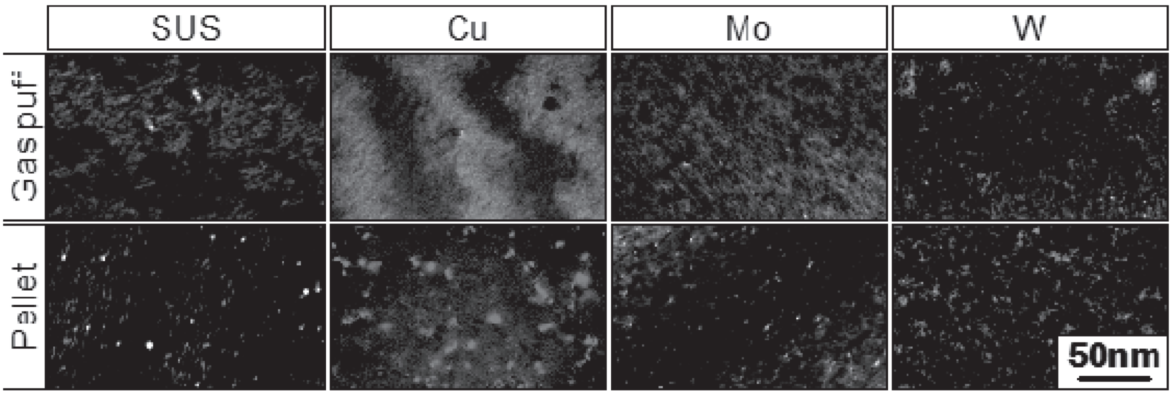

Fig.3 Dark field images of the microstructures in each probe specimen. White contrasts show dislocation loops.