§36. Surface Modification of Plasma Facing Material by H/He Mixture Plasma Discharge

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The armor materials of the first wall/blanket and the divertor will be subjected by hydrogen isotopes including tritium, neutron and helium produced by DT burning in fusion devices. In particular, behavior of implantation, diffusion and permeation of tritium of the armor materials of the first wall/blanket and the divertor is very important because of the control of fuel, tritium retention, limit of tritium discharge experiment. In addition, beam irradiation experiments have showed that helium irradiation influences hydrogen isotope retention of the plasma facing materials such as tungsten. In the present study, material exposure experiments in LHD have been performed to investigate the synergistic effects simultaneous implantation of hydrogen and helium on hydrogen retention and microstructure changes of materials in high temperature plasma confinement device.

A probe head were transferred to the vacuum chamber position by using the retractable material-probe system equipped with the LHD, and then exposed to hydrogen or hydrogen helium mixture discharges with magnetic axis of 3.6 m and 3.53 m. Three sets of tungsten (W) and SUS316L were mounted on the probe head equipped with a rotatable shatter. The two sets were fixed on the bottom part of the probe head. The one set was exposed 18 hydrogen discharges (H/(H+He)=0.9, ratio of spectroscopic measurement) of 18 s in total, and the other one was exposed by 9 hydrogen/helium mixture plasma discharges (H/(H+He)=0.4, ratio of spectroscopic measurement) of 40s in total. On the other hands, the one set, which was fixed on the surface of the shatter, was exposed by the all discharges after the transfer to the vacuum chamber position. The temperature of the probe head was monitored by thermocouples.

After the exposure, surface morphology was examined by means of scanning electron microscopy (SEM) and energy dispersive spectroscopy (EDS), respectively. In addition, chemical composition including in hydrogen and helium has been examined by Rutherford Backscattering Spectrometry (RBS) and Elastic Recoil Detection(ERD) .

Last fiscal year, ERD analyses of tungsten using 4.0MeV$^{16}O^{4+}$ probe were performed to detect H and He simultaneously. This fiscal year, ERD analyses of tungsten using 2.8MeV$^{4}He^{2+}$ probe have been carried out to do high sensitive analyses for H.

Fig. 1 shows the results of ERD analyses of tungsten using 2.8MeV$^{4}He^{2+}$ probe. H was detected on all tungsten samples. Amount of H on the tungsten sample which was exposed to all discharges is almost equivalent amount of H on the tungsten sample which was only exposed H discharges. This result suggests that He mixture with H suppresses H absorption on the tungsten sample. Exposure experiment of higher fluence of hydrogen/helium on tungsten surface will be required.

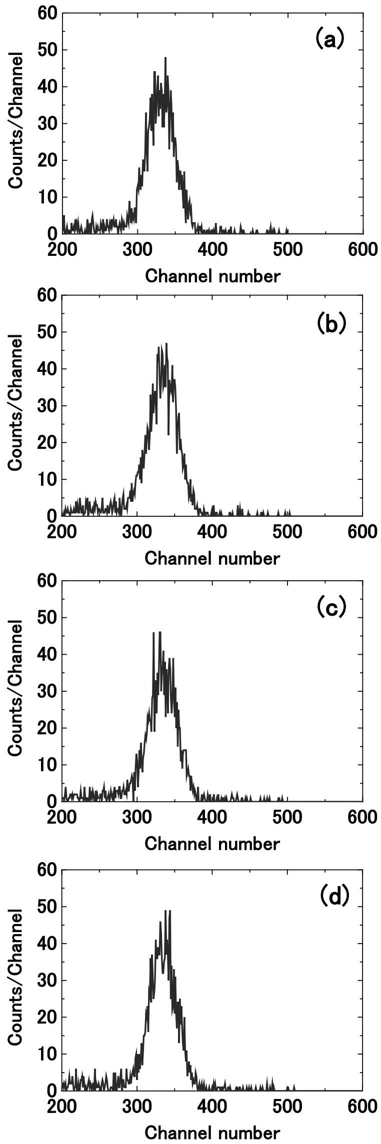

Fig.1 ERD analyses of W (a) unirradiated W, (b) W irradiated by all discharges. (c)W irradiated by hydrogen discharges (H/(H+He)=0.9, ratio of spectroscopic measurement), (d) W irradiated by hydrogen and helium mixture discharges (H/(H+He)=0.4)