Effects of hydrogen and helium irradiation on optical property of tungsten (P2-F-471)

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Plasma-wall interactions cause surface modification, compositional and structural change on material surface due to sputtering, impurity deposition and radiation damage, etc. As a result, optical property (response of electron and lattice on material for electromagnetic wave) on surface of the plasma facing components would be changed. In particular, diagnostic components, such as metallic mirrors, mounted close to the plasma will be subjected by plasma particles such as hydrogen isotope and helium in the fusion devices. It is well recognized that decrease of optical reflectivity of the metallic mirrors due to the plasma-material interaction will be critical issues for the plasma diagnosis. In the present work, tungsten has been irradiated by hydrogen and helium beam. After that, optical reflectivity and surface modification have been measured to investigate fundamental process of optical property change due to hydrogen and helium beam irradiation.

Samples used in the present experiment are powder metallurgy tungsten. Hydrogen and helium irradiations are performed in an ion beam facility at JAEA, the Particle Beam Engineering Facility (PBEF). The energy of hydrogen and helium is 19.0 and 18.7 keV, respectively. Beam duration is 1.3 – 3.5 s. The samples are irradiated up to a fluence of the orders between 10^22 and 10^24 He/m^2 by the repeated pulse irradiations of 14–450 cycles. The surface temperature is measured with an optical pyrometer. After the repeated irradiation experiments, surface modification and composition are examined with a scanning electron microscope (SEM) and a scanning probe microscope (SPM), etc. In addition, the optical reflectivity is measured in the wavelength range of 190 – 2400 nm using an ultraviolet-visible and near-infrared spectrophotometer.

The reflectivity after the irradiation decreases depending on fluence and a peak temperature of the samples during the irradiation. In addition, their reflectivity spectra also change. This means that electron band structure near surface of the tungsten samples is also modified. In particular, in the case of the helium irradiated tungsten which remarkable fine modification occurs, reflectivity become to be below a few % in the measured wavelength range. Present results indicate that the beam irradiation changes optical property and band structure of electron near Fermi energy on surface of tungsten.