§12. Study on Erosion, Transport and Redeposition of Wall Materials in GAMMA-10 and its Contribution to Divertor Development

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GAMMA-10 end plasmas have several advantages in making plasma materials interaction experiments comparing linear plasma devices such as high ion energy with Maxwell distribution and presence of a high magnetic field. Under these conditions, plasma ions impinging plasma facing materials (PFMs) have oblique incident angles and energy distribution, which significantly affect erosion of PFMs. In addition, after ionization of sputtered atoms their motion was strongly affected by the strong magnetic field. Due to these features, GAMMA-10 provides unique experimental environment to simulate plasma materials interaction.

In this study, chemical sputtering of graphite and local transport phenomena of carbon atoms together with high Z atoms are investigated. Last year, graphite and Mo samples were installed at the E-divertor test section with a sample surface tilted 45 deg from magnetic lines of force. Erosion flux of carbon and Mo will be measured by a framing camera with an appropriate spectral line filter. Images of the framing camera were shown in Fig. 1 for three atoms ((a) H_α, (b,c) Mo, and (d) C). In these measurements, frame rates were adjusted to 100 fps for H_α and MoI and 250 fps for C III. In the center of the roof target, a Mo plate was installed and on both sides of the Mo plate C plates were installed. In addition, SUS316 material was exposed at both ends of inclined surface.

From Fig. 1 (a), H_α light was brighter in front of Mo and SUS than graphite though this is not significant, probably because of higher ion reflection coefficient of H atoms and smaller H absorption in metals (Mo and SUS). Light emission profiles from Mo atoms are shown in Fig. 1(b) and Fig. 1(c). Intensity of light is slightly stronger for wavelength of 392 nm, because this is a resonant line. Mo line intensity is localized near a surface of the Mo target, indicating sputtered Mo atoms have ionization length of about a couple of cm. Detailed analysis will be performed near future. Mo light is also seen from the SUS target. The reason could be inclusion of Mo in SUS (2~3 %). For carbon, since target temperature is close to RT and ion energy is more than 100 eV, physical sputtering is a dominant process for erosion. Sputtering of Mo suggests sputtering of C from graphite. But CIII light emission is not very clear due to low intensity of CIII light and long ionization length of carbon in plasmas. Local deposition of Mo and C atoms will be analyzed in detail by XPS and ion beam analysis. Simulation on migration of target elements is also planned with use of an EDDY type simulation code.

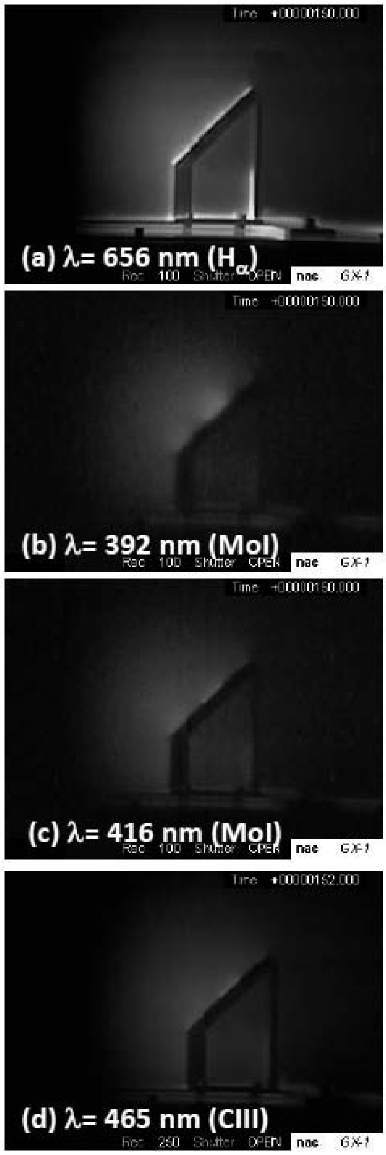

Fig. 1 2D images of emission of H_α (a), MoI (b, c), and CIII.

Combined scientific meeting on PWI study was organized with the other regular meetings, Plasma Research Center symposium (Tsukuba University), and Fusion Plasma and Engineering clusters meetings. In this combined meeting, presentations and discussions of research status and issues on detached plasma, open field magnetic configurations, and tungsten divertor were performed.

Prof. Ohno gave a review presentation on the detached plasma. Prof. Kado gave a recent research topics on diagnostics of low temperature detached plasmas. Divertor plasma experimental results in LHD and JT-60U were presented by Prof. Masuzaki and Dr. Tanaka in NIFS.

Tungsten divertor is planned for ITER and DEMO because of low sputtering erosion and low T retention. But tungsten is more vulnerable to transient heat loading than graphite mainly because of its low temperature brittleness and melting. In this meeting, recent tungsten works for ITER and DEMO were presented and intensively discussed. Detailed topics are ; effects of neutron irradiation (transmutation and associated decay heat), simulation of tungsten erosion in DEMO, ELM-like heat pulse effects by a pulsed plasma gun, material properties of VPS-tungsten coated ferritic steel.