## §4. Effect of Neutrals on Decrease in Heat and Particle Loads on the V-shaped Target in GAMMA10

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To realize a steady-state nuclear fusion reactor, one of the urgent issues is reduction of heat and particle loads onto the divertor targets. Divertor detachment is attractive to reduce heat and particle loads onto the divertor target. Although it is believed that neutrals play important roles to form detached plasmas, fundamental process such as interaction between plasmas and neutrals have not been fully understood yet. This study aims at elucidation of effects of neutrals on reductions of heat and particle loads using a V-shaped target in divertor simulation experimental module (D-module) in GAMMA 10/PDX. Recently, we have started to measure an absolute $H_2$ gas pressure in the D-module by an ASDEX-type ionization gauge[1)] installed into the D-module.

Effects of $H_2$ gas pressures in the D-module on a production of detached plasmas on V-shaped target have been investigated by $H_2$ gas injection into the D-module during plasma irradiation to the V-shaped target. ICRF-heated plasmas were produced in GAMMA 10/PDX. Time evolutions of main plasma parameters at the central were uniform: a diamagnetism of ~$2 \times 10^{-5}$ Wb and a line-averaged electron density of $5 \times 10^{-5}$ $m^{-3}$. End loss plasmas were irradiated for 400 ms to the V-shaped target. The angle of the V-shaped target was set at 45°. $H_2$ gas loaded in the reservoir (490 $cm^3$) with a pressure of up to 100 kPa was injected into the D-module from 200 ms. $H_2$ gas pressures in the D-module were measured by the ASDEX-type ionization gauge. Electron temperatures and densities were measured by Langmuir probes installed at the V-shaped target and an upstream connected by a magnetic line.

Figure 1 shows time evolutions of $H_2$ gas pressure in the D-module. Although absolute $H_2$ gas pressures are unclear due to noise, the $H_2$ gas pressure in the D-module increases with that in the reservoir. Figure 2 shows time evolutions of plasma parameters measured by Langmuir probes.

**(a) 25 kPa:** Before $H_2$ gas is injected, the electron temperature and the density are uniform at 30-40 eV and $0.2 \times 10^{17}$ $m^{-3}$, respectively, on the V-shaped target and the upstream. The plasma pressure is also uniform at $1.0 \times 10^{18}$ eV $m^{-3}$. After ~300 ms, the electron density increases with $H_2$ gas pressures. The electron density is uniform. On the V-shaped target, the electron temperature and the density decrease. Although increase in the plasma pressure on the V-shaped target is larger than that at the upstream.

**(b) 50 kPa:** The plasma parameters change with $H_2$ gas pressures after ~250 ms. At the upstream, the electron temperature decreases in 20 eV, and the electron density increases in $1.4 \times 10^{17}$ $m^{-3}$. On the V-shaped target, the electron temperature decreases in 10 eV, and the electron density increases in $1.0 \times 10^{17}$ $m^{-3}$. In this case, the plasma pressure on the V-shaped target is lower than that at the upstream. This indicates that detached plasmas are start to be formed on the V-shaped target.

**(c) 100 kPa:** The plasma parameters change with $H_2$ gas pressure after ~220 ms. At the upstream, the electron temperature decreases in 10 eV, and the density increases in $3.0 \times 10^{17}$ $m^{-3}$. The electron temperature and density on the V-shaped target are lower than those at the upstream: 4 eV and $1.0 \times 10^{17}$ $m^{-3}$, respectively. The plasma pressure on the V-shaped target is lower than that at the upstream side. This indicates that detached plasmas are produced on the V-shaped target.

In this study, effects of $H_2$ gas pressure in the D-module on a production of detached plasmas on the V-shaped target are investigated With an increase in $H_2$ gas pressures in the D-module, the electron temperature decreases from 30-40 eV to 10 eV, and the electron density increases from $0.2 \times 10^{17}$ $m^{-3}$ to $3.0 \times 10^{17}$ $m^{-3}$ at the upstream. At V-shaped target, the electron temperature decreases in 4 eV, and the electron density increases in $1.0 \times 10^{17}$ $m^{-3}$ at the highest $H_2$ gas injection rate. In this case, the plasma pressure on the V-shaped target is lower than that at the upstream. This indicates that detached plasmas are formed on the V-shaped target.

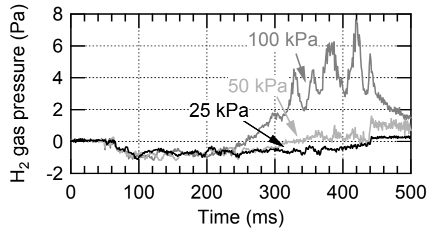


Fig. 1 Time evolutions of $H_2$ gas pressure in the D-module for different $H_2$ gas pressure in the reservoir.

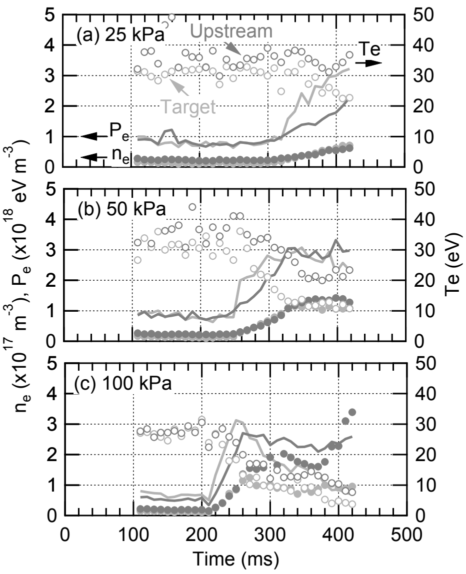


Fig. 2. Time evolution of plasma parameters measured by Langmuir probes for different $H_2$ gas pressures in the reservoir at (a) 25, (b) 50 and (c) 100 kPa.

1) Haas, G., et al.: J. Nucl. Mater. **121** (1984) 151.