§45. Study on Reflected Particles from Plasma Facing Material

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Reflection of ions at a tungsten target was investigated experimentally in a linear plasma device. The aim of this work is to study the energy distribution of the reflected particles from the plasma facing surfaces systematically. The energy distribution of the reflected particles is affected by the experimental conditions, such as components of plasma ions, plasma facing materials, the angle between the material surface and magnetic field line, potential drop between the plasma and material surface.

The experiment has been carried out in the linear plasma device TPD-I. The target plate is made of tungsten with a size of 10 × 10 mm. The target plate is set perpendicular to the magnetic field line. The detector system for the reflected particles is set with an angle of 65 degree to the magnetic field on TPD-I. The reflected particles from tungsten target get struck the neutral - negative convertor made of Cu in diagnostic chamber.

To evaluate the reflected particles properties, normalized value $P_{Cu\text{-}e}$ is introduced. This value is probability of the negative charge release when one incident particle comes into the target plate. Two $P_{Cu\text{-}e}$ values, that is, for experiment and calculation, are defined as follows, respectively;

$$P_{Cu-e}{}^{TRIM} = \int_0^\infty \gamma(E)\eta(E)\frac{dN}{dE\cdot d\Omega}dE \quad (1)$$

$$P_{Cu-e}{}^{Exp.} = \frac{I_{out}(E_s)}{G_{MCP}I_{sat}\frac{\Omega}{4\pi}} \quad (2)$$

where dN/dE•dΩ [/eV•sr] is energy distribution of the reflected particle energy from calculation [1] based on TRIM.SP. [2], I_{sat} is ion saturate current to the target plate, E_s is sheath potential in front of target plate, γ(E) is the coefficient of negative charge release, η(E) is the coefficient which consists of collecting negative charge at MCP (ε) and scattering loss caused by collisions between reflected particles and thermal working gas (ξ(E)), G_{MCP} is gains of amplifiers and I_{out} is electron current in this system. ξ(E) depends on the energy of the reflected particles, and ε is constant. Figure. 1 shows sheath potential dependence of $P_{Cu\text{-}e}{}^{Exp.}$ for various working gas pressures. Elastic cross section is estimated from this pressure dependence between reflected particles and thermal working gas. The obtained cross section is good agreement with Ref. [3]. γ(E) strongly depends on energy below 100 eV. If sheath potential is deeper in case of lower ion temperature, $P_{Cu\text{-}e}{}^{TRIM}$ value is almost same because γ(E) dependence is weak over 100 eV and dN/dE•dΩ is almost same. On the other hands, it is possible to estimate from $P_{Cu\text{-}e}$ value in lower sheath potential which strongly depends on γ(E) in case of lower ion temperature. Figure 2 shows relation between sheath potential and $P_{Cu\text{-}e}$ in various T_i in case of helium dischrge at 0.9mTorr, and it is assumed η = 0.21. This results suggests ion temperature between 2 to 3 eV with helium discharge at 0.9 mTorr in TPD-I.

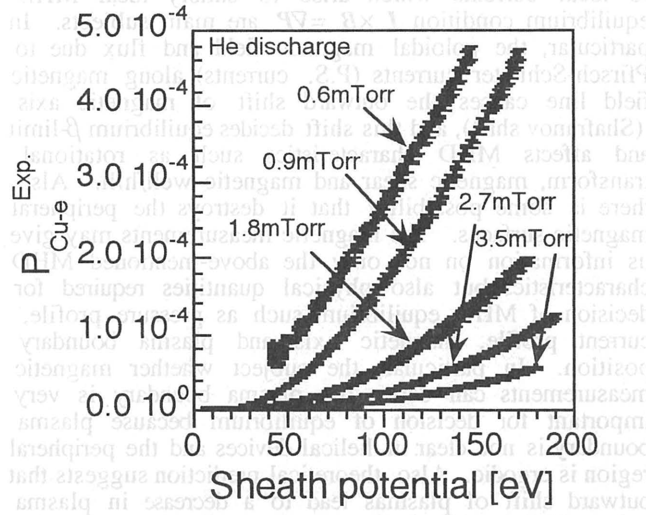

Fig.1 The dependence of the sheath potential in various pressure of helium discharge.

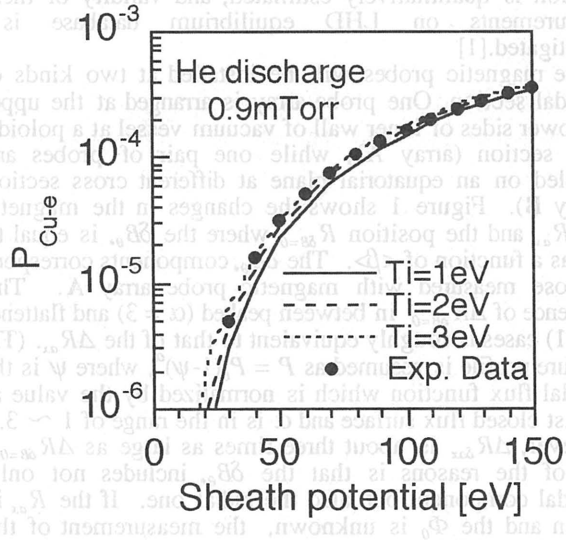

Fig.2 Estimation of ion temperature for helium discharge from the various T_i case.

Reference

[1] Hasegawa.Y. et al., J. Plasma and Fusion Reserch SERIES Vol.1 (1998) 390-393

[2] Eckstein, W., Computer Simulation of Ion-Solid Interaction(Springer, Berlin, 1991).

[3] Ruzic. D. N. et al., PPPL-2210 (1985)