§4. Heat Transport in Hydrogen and Helium ECRH Plasmas on LHD

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Mass dependence of the confinement properties is one of the mysteries in the magnetic confinement fusion devices. The energy confinement time τ_E generally increase with mass M: $\tau_E \propto M^a$ where the exponent a is greater than 0 in tokamaks[1], while in stellarator, clear mass dependence of the performance was not reported in ECH plasma[2]. To clarify the mass effects on the confinement in helical devices, the confinement property of hydrogen and helium plasmas were compared on the Large Helical Device (LHD).

1 MW ECRH was applied on hydrogen/helium plasmas to investigate dynamic/steady transport properties. A ratio of H to He are approximately 90% in "hydrogen" and 30% in "helium" discharges. ECRH was modulated to evaluate ECRH power deposition for the transport analysis. Figure 1 shows the temporal evolution of power of injected EC waves, the line averaged electron density, the central electron and ion temperature. While there is no significant difference in the electron temperature between hydrogen plasmas and helium plasmas, the ion temperature measured by a crystal spectrometer was clearly larger for helium plasmas than for hydrogen plasmas. The ECRH total power and deposition profiles were evaluated from the electron temperature, electron density and the diamagnetic stored energy experimentally, and calculated by ray trace code LHDGauss. The power balance analysis was performed using TASK3D[3] with estimated ECRH power deposition to evaluate the electron and ion heat diffusivity coefficients. We assumed that H ratio is 100 % for "hydrogen plasmas" and He ratio is 100% for "helium plasmas" in the power balance analysis using TASK3D. Figure 2 shows comparison of the profiles of the electron and ion temperature, the ECRH absorbed power density, the volume-integrated ECRH absorbed power, the electron and ion thermal diffusivity coefficient of hydrogen and helium plasmas. The profile of the ion temperature was assumed parabolic distribution with the central ion temperature measured by a crystal spectrometer. Because the EC heating position estimated from the electron temperature measured by the electron cyclotron emission systems was $\rho < 0.4$, the evaluation of the electron diffusivity is valid at only $\rho > 0.4$. There is no difference in the electron heat diffusivity at $\rho > 0.4$ for hydrogen and helium ECRH plasmas. The difference in the central ion temperature measured by a crystal spectrometer may indicate the ion heat diffusivity is larger for hydrogen plasmas than for helium plasmas.

1) Urano, H. *et al.*: Nucl. Fusion 53 (2013) 083003.
2) Stroth, U. *et al.*: Physica Scripta 51, (1995) 655.
3) Yokoyama, M. *et al.*, Plasma Fusion Res. 8 (2013) 2403016.

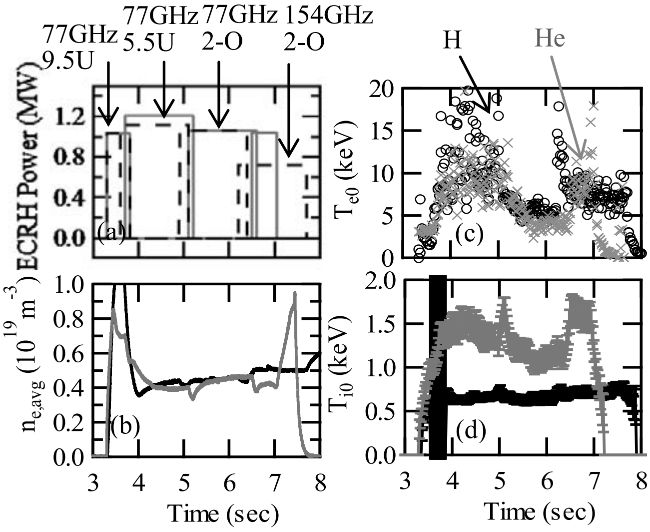

Fig. 1. Temporal evolutions of (a) ECRH power, (b) line-averaged electron density, (c) central electron temperature, (d) central ion temperature of hydrogen (black) and helium (gray) plasmas.

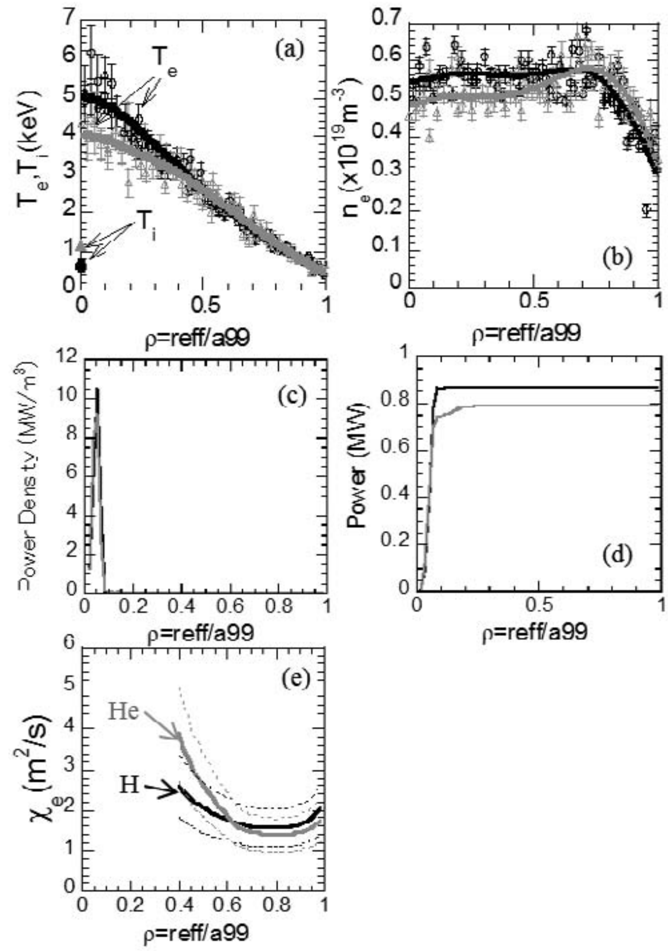

Fig. 2. Profiles of (a) electron and ion temperature, (b) electron and ion density, (c) ECRH power density, (d) volume-integrated power, (e) electron heat diffusivity coefficient and its error (the dash lines) for hydrogen (black) and helium (gray) ECRH plasmas.