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Extension of Operational Regime in High-Temperature Plasmas and Effect of ECRH on Ion Thermal Transport in the LHD

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In future reactors, the fusion reaction is expected to be sustained under the electron heating dominant condition, where both ion temperature and electron temperature are high. Thus the characterization of the thermal transport for the plasmas, of which ion temperature and electron temperature are simultaneously high, is necessary. In recent years, an integration of high ion temperature and high electron temperature has been successfully achieved in the LHD. In FY2014, one high power gyrotron (154 GHz, 1 MW) was newly installed, and since then 5 gyrotrons with 1-MW output power each have been under operation and the total ECRH power reached 5.4 MW. We finely adjusted the ECRH injection angle and the EC wave polarization taking account of the actual plasma profiles in real time. Simultaneous high ion temperature and high electron temperature regime was successfully extended due to the upgraded ECRH system and the optimization of the ECRH injection. Such high-temperature plasmas were realized by the simultaneous formation of an ion ITB and an electron ITB by the combination of high power NBI and ECRH. In the heating condition, a seesaw-like behavior of the ion thermal transport between core and edge has been observed. Both in the plasma core and the edge, the electron temperature and the gradient increased with increase in ECRH power. On the other hand, the ion thermal confinement was degraded in the plasma core with increase of the ratio of the electron temperature to the ion temperature by the on-axis ECRH. In contrast, the ion thermal confinement was found to be improved at the plasma edge. The ion thermal diffusivity normalized by the gyro-Bohm factor was found to be reduced by 70% at the edge. Then the spatiotemporal coherence of the electron density fluctuations at the plasma edge clearly decreased. The improvement of the ion thermal confinement at the edge led to increase in the ion temperature in the entire plasma region even though the core transport was degraded.

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