Observations of Impurity Hole in High Ion Temperature Discharge on LHD

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An extreme hollow profile of carbon impurity is observed in high ion temperature plasma on the large helical device (LHD). The profiles of ion temperature, toroidal rotation velocity and carbon impurity are measured with charge exchange spectroscopy using the charge exchange line of fully ionized carbon. The neutral beam injector which has a positive ion source (p-NBI) with the beam energy of 40 keV is used for the CXS measurement. Three NBIs with a negative ion source (n-NBI) are injects the beam into the plasma tangentially, while the p-NBI injects the beam into the plasma perpendicularly.

The plasma with the ion temperature of 5 keV and the electron density of 1 x 10^{19} m^{-3} is produced by the NBI injection. In the discharge, three n-NBIs are injected after the injection of the positive NBI. Because the positive NBI tends to change the profile of the plasma densities, the injection timing of the n-NBI is optimized to make the power of n-NBI effectively deposits into the plasma. The large toroidal rotation is observed in the high ion temperature plasma. The direction of the toroidal rotation (co or counter) depends on the direction of the n-NBI. The decrease of carbon impurity is also observed at the core of the high ion temperature plasma.

The decrease of the carbon impurity is clearly observed on the high Z discharge for high ion temperature operation. The carbon pellet was used for the supplying of the high Z impurity into the core of the plasma. The electron density increases rapidly just after the pellet injection, and then decreases with the time scale of a few 100 msec. The impurity profile suddenly changes to extreme hollow profile while the ion temperature grows higher in the decay phase of the electron density. This suggests that there is a transition phenomenon in the impurity transport.