Non-inductive plasma start-up experiments on the TST-2 spherical tokamak

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Non-inductive plasma start-up and subsequent plasma current ramp-up by the lower-hybrid (LH) wave are being investigated on the TST-2 spherical tokamak at the University of Tokyo (R_0 = 0.36 m, a = 0.23 m). A newly-developed traveling wave antenna called the capacitively-coupled combline (CCC) antenna, installed on the low-field-side midplane, is being used to excite the LH wave. Plasma current ramp-up up to 20 kA has been achieved so far in the low toroidal magnetic field regime, B_t < 0.1 T. The current drive efficiency is observed to drop sharply just below the mode conversion density limit. This density limit increases approximately linearly with the toroidal magnetic field. Results of RF power modulation experiments indicate that a large fraction of energetic electrons generated by the LH wave are lost quickly. Full-wave modeling is being carried out to describe quantitatively the experimental results of LH current drive on TST-2. The maximum achievable plasma current is found to increase with the magnetic field. Further ramp-up to higher plasma currents would require operation at higher toroidal fields and/or an improved wave launching. An upgrade of the toroidal field coil power supply is in progress. A new top-launch CCC antenna is also being fabricated. The LH wave launched from the top of the plasma undergoes a more favorable $n_{\parallel}$ up-shift and results in an almost complete absorption during its first pass through the plasma. This is expected to avoid parasitic dissipation of the LH wave in the scrape-off layer plasma. The achievement of higher plasma currents is expected to contribute to an improved current drive efficiency by providing better confinement of energetic electrons.

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