§18. Particle Transport Study on CHS with Tracer-Encapsulated Solid Pellet Injection

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The new diagnostic method for the local particle transport measurement, which is based on the concept of tracer-encapsulated solid pellet (TESPEL) [1], has been implemented in CHS experiments. The diffusion coefficient D is derived from the measured transport motion of tracer particles deposited locally by the injected TESPEL. The TESPEL consists of polystyrene as an outer shell (diameter 300 μm, wall thickness 50–100 μm) and LiH as an inner core (a crystal of 40–60 μm size). The TESPEL production technique is described in detail in [2]. The pellet is accelerated by a pulse of He gas to the velocity of 300 m/s. The target plasma of CHS is heated by the 1 MW NBI, which is also used as a neutral beam source for the CXRS spectroscopy of the Li ions.

The light emission from the ablating pellet was measured in H_α and Li I / Li II lines simultaneously with high time resolution. The pellet cloud was also photographed through H_α and Li I / Li II filters by CCD cameras from two directions. With this system, the exact location and width of the deposition of tracer material were measured, and a high localization of the tracer has been achieved (typically, only 0.5–3 cm in radial direction).

After being fully ionized, Li^{+3} ions form a toroidal annular domain, and then diffuse in radial direction. The diffusion is measured by observing the Li III light (λ=449.9 nm) originated from charge-exchange with neutral hydrogen of the NBI. For that, an array of photomultipliers with spatial resolution of up to 7 mm and time resolution of up to 10 μs is set up at the location of the neutral beam. For subtracting the background Li III light from the peripheral plasma, an identical set of photomultipliers was installed at the neighboring port. An example of the evolution of Li^{+3} density measured at different radii is presented in Fig. 1. Owing to the highly localized initial deposition of the Li ions, the local value of the diffusion coefficient D can be easily calculated from the measured time delay of achieving maximal density at the corresponding radius. In general, the obtained values of D are smaller in the core plasma (0.05–0.15 m^2/s) and larger at the periphery (0.15–0.80 m^2/s).

This technique has been applied to the data obtained in various configurations of CHS plasmas in order to deduce a dependence of D on the plasma density and temperature. For the case of the density dependence, no clear tendency was observed. Instead, as it is seen from Fig. 2, larger values of D were measured for the shots with higher electron temperature. Thus, it can be concluded that for the tested to date range of plasma conditions the diffusion coefficient depends weakly on the plasma density and increases with the electron temperature.

The obtained results have demonstrated the efficiency of the described diagnostic method for the local transport measurements.

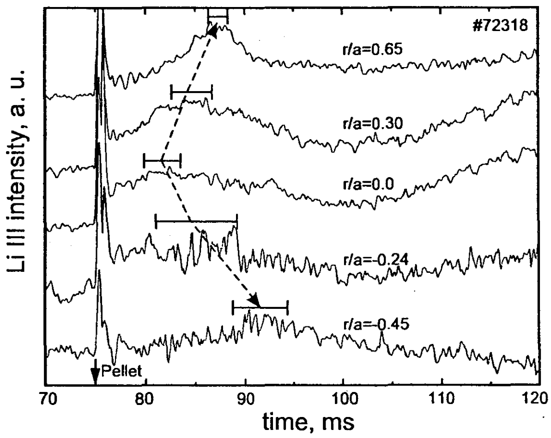

Fig. 1. Li III CXRS signal subtracted by reference signals at different radial positions. The two arrows indicate the propagation of the density perturbation.

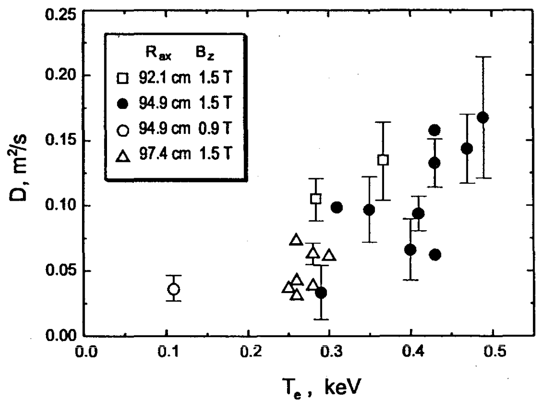

Fig. 2. Dependence of the diffusion coefficient for the central plasma on the electron temperature.

References

1) S. Sudo, J. of Plasma Fusion Research, **69**, (1993) 1349.
2) K. Khlopenkov, S. Sudo, Rev. Sci. Inst. **69**, (1998) 319.