§59. Preliminary Results of Tracer-Encapsulated Solid Pellet Injection on LHD

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In order to measure the local particle transport, a new diagnostic method has been implemented in LHD experiments, which is based on the concept of tracer-encapsulated solid pellet (TESPEL) [1]. Diffusion coefficient D can be 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 0.5–0.6 mm) and LiH as an inner core (80-100 μm size) [2]. The pellet is accelerated pneumatically to the velocity of 300 m/s.

The total light emission from the ablating pellet was measured by photo-multipliers (PM) in H_α and Li I lines simultaneously with time resolution of 1 μs. Knowing the pellet velocity, the time dependence is translated to the pellet position in plasma, and thus tracer location and deposition length can be measured. Figure 1 shows an example of the observed ablation rate. The difference between the pellet with tracer and the reference pellet is obvious, although some background Li I emission is present.

The time integrated images of the pellet cloud were obtained through H_α and Li I filters by CCD cameras from two directions (Fig. 2). The obtained images are in good agreement with the PM signals. Background light during ablation of the shell is attributed to a larger spectral width of the Li I filter used (3.6 nm for CCD compared to 1.1 nm for the PM). Both observation methods confirmed that a high localization of the tracer has been achieved (typically, only a few cm in radial direction).

Being deposited locally in plasma, the tracer is fully ionized and the Li^{+3} ions form a toroidal annular domain, which 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, two detector arrays are installed at the location of the neutral beam (port 10.5L) and at the port without NBI (port 7.5L). The net CXRS signal is obtained by subtracting signals from the corresponding detectors. Each detector consists of a lens, optical fiber, and PM equipped with Li III filter. This provides high spatial resolution of 12.5 mm along the minor radius and time resolution of 10 μs. The local value of diffusion coefficient D can be calculated from the measured characteristic time of Li^{+3} density decay. Due to a low S/N ratio of detected signals achieved up to date, only rough estimations are possible. Preliminary calculations show that for the case of $\overline{n}_e = 0.15 \cdot 10^{19}$ m^{-3} and $T_e(0) = 2.9$ keV, the average value of D is 0.13 m^2/s, and for $\overline{n}_e = 1.1 \cdot 10^{19}$ m^{-3}, $T_e(0) = 3.4$ keV, D is 3.1 m^2/s.

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

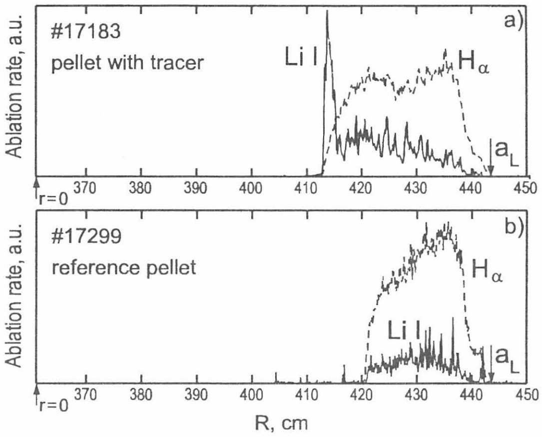

Fig. 1. Ablation rate of TESPEL (a) and a reference pellet without tracer (b). The local deposition of the tracer is proved by the upper figure.

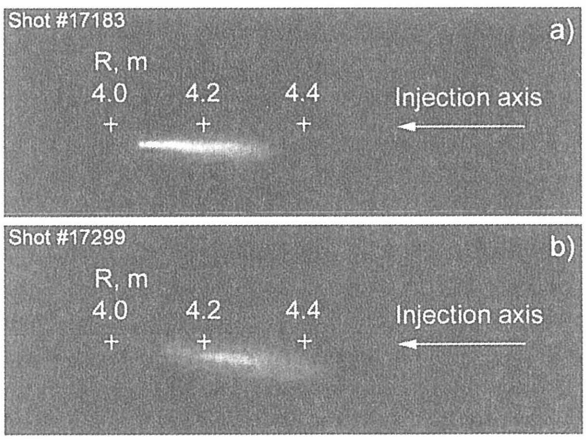

Fig. 2. CCD images of the ablating TESPEL (a), and reference pellet (b), obtained with Li I filter (λ_0 = 671.7 nm). Tracer ablation is clearly seen in the upper image in the area of R = 4.05–4.10 m.

References

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