§19. Li Spectral Lines in TESPEL Injection in CHS

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In the particle transport study using tracer impurities, the estimation of the recycling effect is an important issue. A LiII line emission after the Li pellet injection suggesting the impurity recycling was observed in Heliotron-E. Also in the tracer-encapsulated solid pellet (TESPEL)[1] injection in CHS, a preliminary result was obtained by the spectroscopic measurements of LiII(λ =548.5 nm) and LiIII(λ =449.9 nm) spectral lines. The typical bulk electron density increase due to the TESPEL injection was less than the factor of 2, therefore the change of other bulk plasma parameters (e.g. the electron and ion temperatures) due to the injection is considered to be also smaller than 50%. The bulk ion temperature was measured with charge exchange spectroscopy (CXS, CVI: λ =529.0nm) with the integration time of 20ms. LiII and LiIII spectral lines were also measured by using a spectrometer with a CCD detector with the integration time of 20ms.

Figure 1 shows the radial distribution of LiII intensity measured with a spectrometer via the tangentially viewing chords. (In these experiments, the vertically viewing chords that we have were used for the CVI-CXS and the photo-multiplier measurements of the LiIII line intensity[1].) These tangentially viewing chords pass also the horizontally elongated cross section where the TESPELs were injected. However, the LiI spectral line was not observed with this spectrometer. It indicates that the viewing chords at the horizontally elongated cross section have a displacement in the vertical direction from the pellet trajectory and thus the observed LiII and LiIII lines were not emitted from the ablation clouds but from the deposited or recycling ions. Although the radial broadening due to the chord and time integration exists, the peaking of the LiII intensity near the edge and it's continuance during about 20-40ms indicate that this spectral line is emitted mainly from the recycling ions. The intensity profile of LiIII line, which is partially caused by the charge exchange of fully ionized Li and the heating neutral beam, does not show a clear peaking indicating a spatially localized particle deposition or a recycling since the time scale for the diffusion of the fully ionized Li is the order of 1~10ms [1] and is faster than the integration time of the CCD detector, and fully ionized Li can exist in the almost all region of the plasma.

Figure 2 shows the Li ion temperatures given by the Doppler broadening of the LiII and LiIII lines. The temperature given by the LiII line is lower than that given by the LiIII line and CVI-CXS. This small line width also indicates that the LiII line is emitted not from the core region where the core of TESPEL ablated but from the edge region. The difference between the temperatures given by the LiIII line and CVI-CXS is caused by the effects of chord integration along the tangentially viewing chords and the electron impact excitation of Li^{2+} ions. The charge exchange spectroscopy of Li lines with the vertically viewing chords to measure the more precise density and temperature profiles of each ionization states for investigating the recycling effects is planned in the future CHS experiments in Toki site.

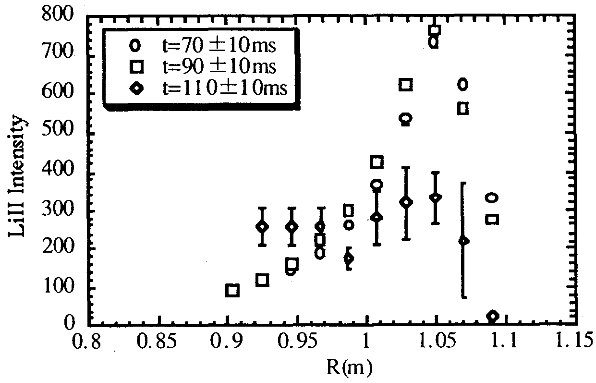

Fig.1 LiII intensity. The TESPEL was injected at t=65ms. The values for the abscissa (R) are defined as the major radii of the intersections of the chords and the vertically elongated cross section.

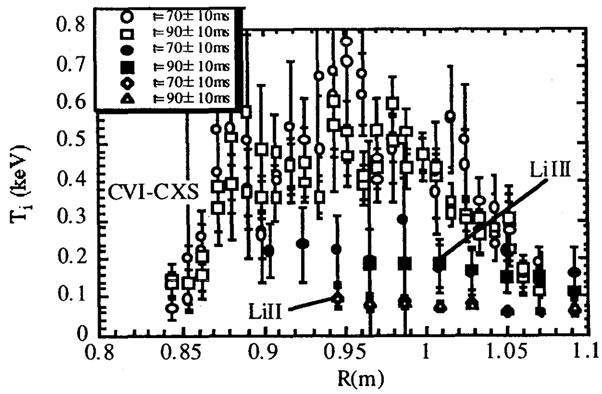

Fig.2 Ion temperatures given by the Doppler broadening of LiII and LiIII lines and the charge exchange spectroscopy of CVI line.

Reference

1) Sudo,S., Khlopenkov,K.V. et al., in 17th IAEA(Yokohama,1998)