§20. A New Diagnostic for Particle Transport Study with Tracer-encapsulated Solid Pellet Injection

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Transport of a magnetic confined plasma is still one of the key subjects to be clarified because of its importance for fusion reactor development. In order to promote particle transport study, the concept of tracer-encapsulated cryogenic pellet (TECPEL) has been proposed [1]. The essential point of this method is based upon the production of both poloidally and toroidally localized particle source as tracers which are deposited at first in very small volume in the plasma. This can simultaneously make diagnostics about radial transport much clearer. Furthermore, the amount of the deposited particles will be clearly identified because of known size of the inner core of the TECPEL.

TECPEL, however, needs both a complicated cryogenic system and somewhat large vacuum chamber. So, for proof of principle, a tracer-encapsulated solid pellet (TESPEL) instead of TECPEL is decided to use in the experiment. TESPEL consists of polystyrene (polymer: -$CH(C_6H_5)CH_2$-) as an outer part and LiH as an inner core. Therefore, TESPEL can be handled at room temperature, and therefore the device can be much simpler, so it is more appropriate to a medium size experimental device such as CHS. The diameter and thickness of the typical polystyrene shell are 300 μm and 50 μm, respectively. The tracer core is a LiH block with a typical diameter of 50 μm. The photo of a produced pellet is shown in Fig. 1. The hole for tracer insertion is seen in Fig.1(a). With changing the focal point of the micro-scope, the cross section of the TESPEL around the equatorial plane is shown in Fig.1(b). LiH core inside of TESPEL is seen in the upper right side. The LiH block is not necessarily to be spherical. The method for accelerating a pellet is pneumatic. A typical accelerating pressure of He gas is 10 atm, and the typical pellet velocity with this pressure is about 300 –400 m/s. The rotating disk in the TESPEL injector has 30 holes for pellet holding.

In one series of experiments, 29 pellets can be injected simply by rotating the disk. Such rotating disk can be renewed in one hour because of simple configuration. The TESPEL injector has a differential pumping system as in case of usual pellet injectors. Such a TESPEL injection system is installed on CHS.

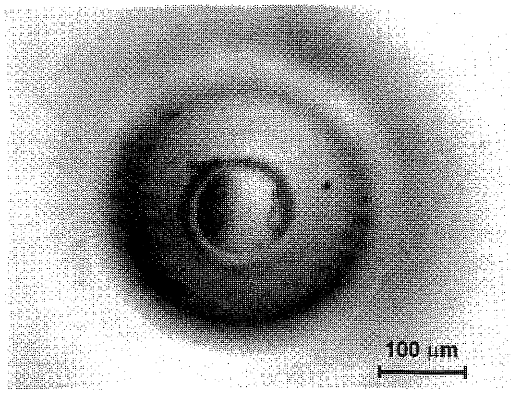

Fig. 1 (a) Photo of TESPEL. Insertion hole is seen in the center.

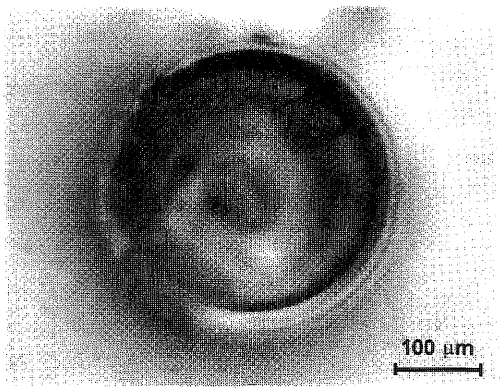

Fig. 1 (b) LiH core inside of TESPEL is seen in the upper right side.

The light emission from the pellet is collected with an optical system, and then it is divided by a half mirror to two photomultipliers, each having a filter. Therefore, simultaneously H_α and Li II (or Li I) can be registered with 10 μs time resolution. Furthermore, two CCD cameras are also equipped for observing the images of H_α, and Li II (or Li I). From the CCD images, it is found that the pellet reaches the central region of the plasma. An intense emission region of Li II is localized in the central region of the plasma.

The LiIII emissions are observed at the location on the NBI beam path and at that without NBI beam path. Thus, the difference of these signals can be interpreted as a pure emission from Li^{+2} ions produced through the process of charge exchange of Li^{+3} ions with neutral hydrogen atoms of NBI. At each location, 10 sets of lens and fiber are equipped. The spatial resolution for observing in the vertical chord is 8 mm. The fibers are connected to photomultipliers through filters for LiIII (449.9 nm)

References

[1] Sudo S., Journal of Plasma and Fusion Research, 69 (1993) 1349.