§1. Investigation of Tritium Behavior and Tracability in Invessel Systems of LHD during D-D Burning

Tanabe, T. (Nagoya University), representative of cooperation program with 59 participants

Retention of hydrogen isotopes in plasma facing carbon materials in tokamaks has extensively studied, and it is found that most of hydrogen is retained in carbon redeposited layers on the inner divertor tiles and plasma shadowed area. However, hydrogen concentration in the carbon redeposited layers is quiet machine dependent and mixing of hydrogen (H) and deuterium (D) makes analysis very difficult. Moreover tritium (T) produced by D-D reaction during D discharges behaves quite differently from H and D, because T produced by the reaction has initially 1 MeV and most of them are directly implanted into plasma facing surface more than 1μm in depth.

In order to discuss detailed tritium behavior in tokamaks, discussion meeting was held at September 4-5, 2004 in NIFS with more than 40 participants. And in particular, profiles of T retentions in TFTR bumper limiters and in the Mark IIA divertor of JET, and H/D and T retention in the W-shaped divertor of JT-60U were compared. The results are summarized in table 1[1].

Hydrogen (H, D and T) is mostly retained in carbon redeposited layers with nearly constant concentration throughout the layers, except high energy triton directly impinging into more than 1μm in depth. However, carbon deposition profiles and hydrogen retention are strongly influenced by geometrical structure of the divertor and tile alignment as well as by magnetic field lines.

In JET and TFTR[2], profiles of tritium retention and carbon redeposition on deposition dominated area agree quite well with hydrogen concentration in the redeposited carbon layers of Q(H+D+T)/C ∼ 0.1-1.0. In TFTR, significant amount of tritium retention was observed on all sides of surface eroded tiles, indicating most of carbon originates from the eroded surface and the eroded carbon does not travel long, though the mechanism of tritium incorporation in the redeposited carbon layers is not clear. In JET, carbon deposition and tritium retention on toroidal gap facing sides were very small. Plasma shadowed area, particularly facing to the pumping duct, was heavily deposited with very high level of tritium. This carbon transport mechanism to plasma shadowed area is note clear, too.

In JT-60U[3,4], toroidal carbon deposition profile were quite uniform with hydrogen concentration less than ∼0.04 in (H+D)/C ratio, which is far less than that for JET and TFTR and carbon deposition at toroidal sides were very small. Contribution of high energy deuterium coming from NBI was appreciable on the outer divertor area, particularly the outer dome area. Collected dust in JT-60U was also very small compared to that of JET.

The differences between JT-60U and JET could be attributed to those of divertor structure, including geometry of pumping duct, tile alignment, and temperature of the divertor tiles but need further studies. It seems possible to reduce tritium inventory significantly by increasing the surface temperature of the plasma facing components.

References
1) Tanabe, T.: Fusion Eng. & Design, to be published
2) Tanabe, T., Bekris, N., Coad, P. et al. J. Nucl. Mater. **313-316** (2003) 478
3) Masaki, K., Sugiyama, K., Hayashi, T. et al.: J. Nucl. Mater. **337-339**(2005) 553
4) Hirohata, Y., Shibahara, T. Tanabe, T. et al.: J. Nucl. Mater. **337-339** (2005) 609

Table. I Comparison of JET with Mark-IIA divertor and JT-60U with W-shaped divertor

	JET	JT-60U
Deposition rate at inner divertor	5g /h 6.5×10^{20} atoms/s	6 nm/s 3×10^{20} atoms/s
Erosion rate at outer divertor	2.3nm/s	0.7nm/s
D/C in deposits	0.4-0.1	< 0.05
Deposition at remote area Collected dust	Louvers at inner pumping slot 1kg	Beneath outer divertor 7g
Pumping slot	Inner side	Bottom
Tile alignment in toroidal direction	A few mm step between tiles	No step between tiles
Divertor temperature	Below 500K with base structure water cooled	Above 600K Only inertially cooled