§ 5. Improvement of Helical Divertor Plate for LHD

Kubota, Y.

For plasma confinement experiments, it is important to reduce outgassing of the plasma facing components because a large amount of desorbed gas will disturb plasma density control and lead to plasma collapse. Actually during the steady state plasma experiments performed by ICRH in the 6th campaign, plasma collapses due to the outgassing of divertor plates were observed. Therefore, improvement of the divertor plate so to reduce the outgassing has been performed at a test facility ACT[1] using a 100-kW electron beam source and a thermal desorption spectrometer (TDS)[2] capable of heating a small sample to 1600℃.

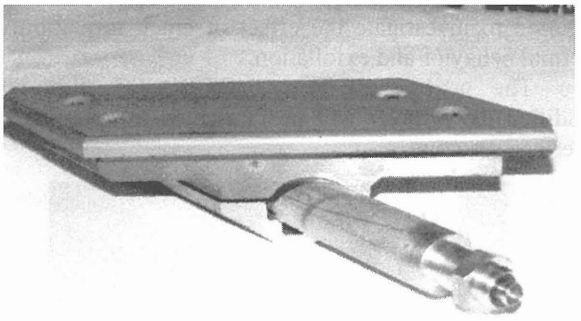

Fig.1 Mechanically joined helical divertor plate for LHD

Fig. 1 shows the mechanically joined divertor plate for LHD, which consists of a graphite armor tile, a copper heat sink, a SS cooling pipe, a SS backing plate, and carbon sheets to improve the thermal contact at the interfaces between the two materials. These components are fixed tightly by eight bolts. In order to evaluate the outgassing of the main materials, thermal desorption spectrum measurement using TDS was performed during linear heating up to 1200℃. Fig. 2 shows the thermal desorption spectra for graphite armor tile (GAT), normal carbon sheet (NCS), and super graphite sheet (SGS), as a reference. The desorbed gas amounts of the materials can be obtained by integrating the spectrum with an effective pumping speed of 400 l/s.

$Q_{A)} = 0.061$ Torr l/g $\Rightarrow TQ_{A)} = 29$ Torr l for GAT(Weight = 480g)

$Q_{B)} = 22$ Torr l/g $\Rightarrow TQ_{B)} = 66$ Torr l for NCS(3g)

$Q_{C)} = 0.17$ Torr l/g $\Rightarrow TQ_{C)} = 0.51$ Torr l for SGS(3g)

$TQ_{A)} + TQ_{B)} = 95$ Torr l

$TQ_{A)} + TQ_{C)} = 29.5$ Torr l

As seen in the figure 2, the amount of desorbed gas for the NCS is much greater compared to the other materials. The main desorbed gas species for the NCS are hydrogen, water, and hydrocarbons. As a result, changing the combination of GAT and NCS to a new combination of GAT and SGS will reduce the outgassing of the divertor plate by approximately two-thirds.

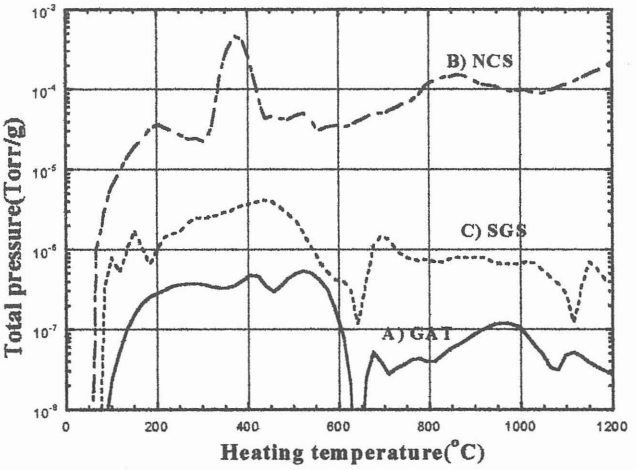

Fig. 2 Thermal desorption spectra of A) Graphite armor tile, B) Normal carbon sheet, and C) Super graphite sheet.

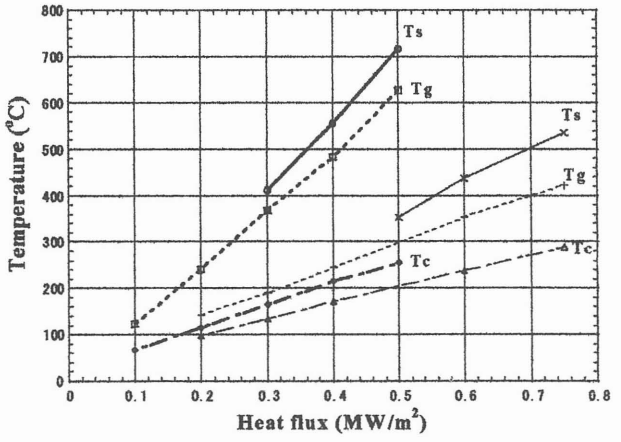

Fig.3 Temperatures (Ts, Tg, Tc) in the divertor plate vs heat flux. Thick lines are for a divertor plate with normal carbon sheets, and thin lines are for a divertor plate with super graphite sheets.

The effect of the exchange for this combination on the thermal performance of a helical divertor was investigated using ACT. Fig.3 shows the relationship between temperatures (Ts, Tg, Tc) of the divertor plate and heat flux on the divertor plate. As shown in the figure, the thermal performance of the divertor is improved greatly (approximately two-fold). The improvement of the divertor plate is expected to be effective for achieving smooth plasma density control during steady state LHD experiments.

References

1) Y.Kubota et al., Internal Report NIFS-MEMO-13(1994).
2) Y.Kubota et al., Internal Report IPPJ-DT-139(1888).