§10. RF Limiter Experiments on JIPP T-IIU

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Concept of RF limiter

An RF current on a limiter surface along the magnetic field produces a strong evanescent RF field E// near the limiter, unless the frequency is chosen to excite propagating waves [1]. This RF electric field forms a ponderomotive potential barrier Ψ_{rf} near the limiter surface. When this potential barrier, which is larger for electrons, is the order of the electron temperature near the limiter,

$$\Psi_{rf} = \frac{e^2 E_{//}^2}{4 m_e \omega^2} \sim T_e,$$

the electron flux to the limiter is suppressed and the DC potential is developed to suppress ion flux. Therefore, the RF limiter can apply the electric field on the plasma surface without extracting ion or electron current as is the case of DC biasing.

The reduction of the heat flux to the limiter and the control of plasma boundary are the purposes of this method.

Experimental results

The movable graphite RF limiter used in the experiment is shown in Fig. 1. The RF current mostly flows along the toroidal magnetic field. The RF frequency f=7.8MHz is in the range $f_{ci} < f \ll f_{ce}$, and the maximum RF power is 1.4kW. The reduction of H_α and CII line intensities at the plasma surface is observed by applying 800W of RF power (Fig. 2). A heavy ion beam probing shows an increase in the space potential (≤100V) at 2cm inside (horizontal) the plasma surface when the RF is applied (Fig. 3). The increase in DC potential by the RF is calculated as $\sim\Psi_{rf}\, T_i / (T_i+T_e)$ and is estimated as few tens of Volts, which is lower than the measured one. Figure 4 shows the vertical profiles of the floating potential behind the limiter measured by a Langmuir probe. Decrease in the floating potential is observed when the RF is applied. The E field shear near the boundary is possibly produced.

The plasma boundary analysis including the RF potential is necessary to understand the effects on the H_α and CII line intensities and the potential profile observed here.

References

[1] T. Shoji *et al.*, J. Nuclear Materials 176 & 177 (1990) 830

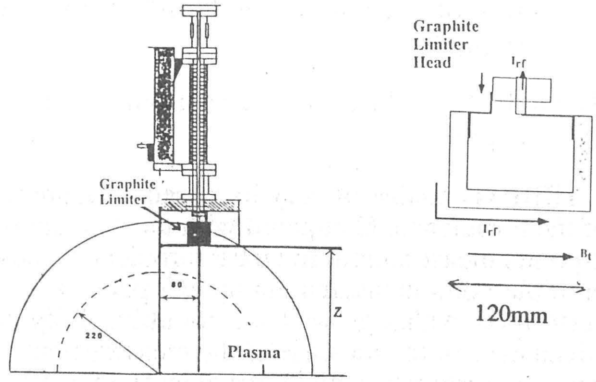

Fig. 1 Graphite RF limiter. The limiter DC potential is grounded.

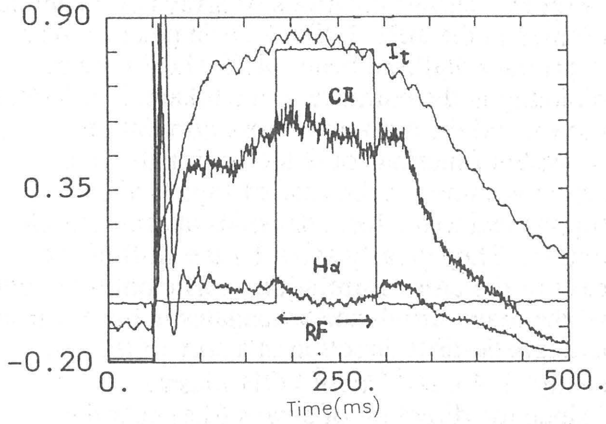

Fig. 2 H_α and CII line intensities versus time. B_t=1.8T, z=21cm, P_{rf}=800W, f=7.8MHz.

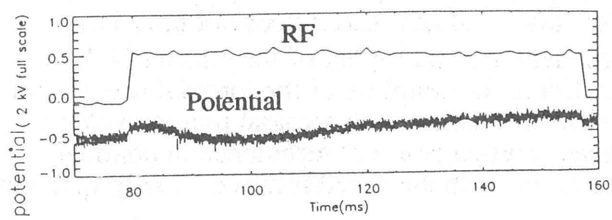

Fig. 3 Change in space potential at 2cm inside (horizontal) the plasma surface measured by heavy ion beam probing (P_{rf}=1.4 kW).

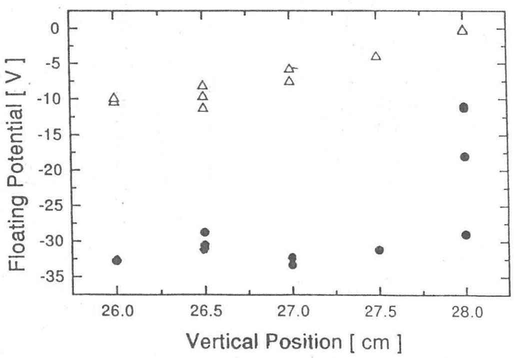

Fig. 4 Change in vertical profiles of floating potential behind the limiter measured by a Langmuir probe. (△: no RF, ●: with RF)