§26. Relation between Impurity Behaviors and Fast Ion Orbit of NBI in CHS

Morita, S., Ozaki, T., Muto, S., Torus Experiment Group

Impurity behaviors of NBI plasmas have been studied in CHS. As an important result it is found that metal impurities are influenced by fast ion orbits of NBI.

The fast ion orbit of NBI in CHS deviates from the magnetic surface due to the gradient B drift. In case of co-injection the guiding center of the drift orbit shifts toward outside in major radius and in case of counter-injection it shifts toward inside. The quantity of the deviation from the magnetic axis is simply expressed by $E^{1/2}/AB_\theta$ (E: particle energy of NBI, A: aspect ratio of torus, B_θ: poloidal magnetic field). The CHS is a low aspect ratio device (A=5) with relatively high energy of NB particles (E=40keV) and is normally operated under low magnetic field (B_t<1T). In these conditions the deviation from the magnetic surface becomes approximately 4-5cm for vacuum magnetic configuration. Thus, the charge exchange loss with slow neutral hydrogen becomes dominant loss mechanism for co-injection case, roughly 10% for the injected power, and orbit loss which is caused by the existence of the inner wall becomes dominant for counter-injected case.

Figures 1-3 show radial profiles of CIII, OV and TiXII for both cases of co- and counter-injections at R_{ax}=88.8cm. The light impurities of carbon and oxygen do not indicate any difference. The behavior of these impurities is affected by the bombardment of thermal plasma particles. On the contrary titanium emission largely increases for counter-injection case. Since the plasma parameters are not so different for both cases, the difference in the emission originates in the behavior of fast ions.

The titanium concentration was studied with magnetic field strength under similar electron density conditions. The results are shown in Fig.4. It is clear that the titanium level in counter-injection is large for every magnetic fields and especially it becomes large for low B_t. This gives a good agreement in a calculation of the orbit loss for the counter-injection case. In this low-field case the titanium radiation loss is 111kW for counter-injection at P_{abs}=0.5MW, whereas it is 14kW for co-injection.

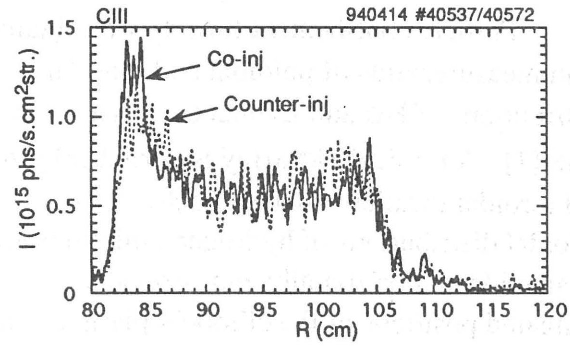

Fig.1 Radial profile of CIII.

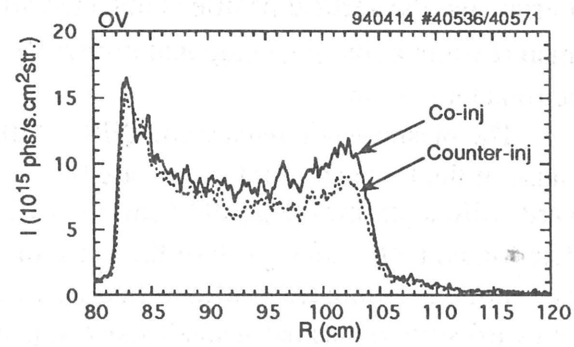

Fig.2 Radial profile of OV.

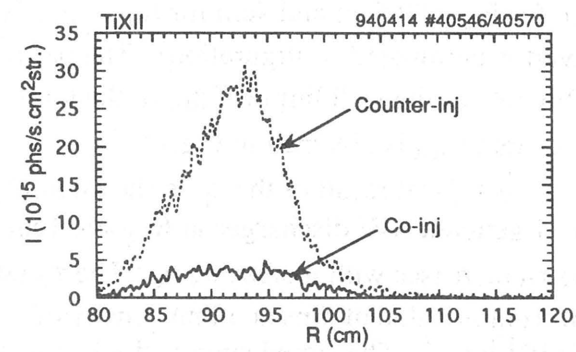

Fig.3 Radial profile of TiXII.

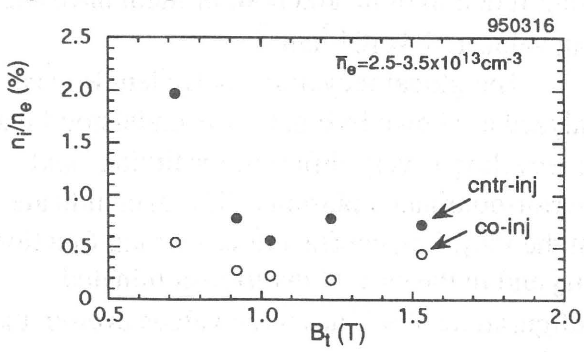

Fig.4 Titanium percentage as a function of B_t.