Impurity diagnostics for edge transport barrier discharges in the Compact Helical System

C. Suzuki, S. Okamura, T. Minami, T. Akiyama, A. Fujisawa, K. Ida, M. Isobe, K. Matsuoka, K. Nagaoka, S. Nishimura, B. J. Peterson, A. Shimizu, C. Takahashi, K. Toi and Y. Yoshimura

E-mail address of the presenting author: csuzuki@lhd.nifs.ac.jp

National Institute for Fusion Science, 322-6 Oroshi-cho, Toki 509-5292, Japan

The physical nature of an edge transport barrier (ETB) observed in helical plasmas has extensively been studied so far in the Compact Helical System (CHS). In order to study the behaviors of impurity ions in the ETB discharges, three different types of impurity diagnostics have been prepared and installed in CHS. A pyroelectric detector was used for a total radiation power monitor as a conventional bolometer. In addition, an absolute extreme ultraviolet (AXUV) photodiode array has been installed to obtain spatial profiles of radiation brightness. Finally, temporal evolutions of individual impurity ion species have been derived from temporal evolutions of vacuum ultraviolet (VUV) spectra measured by a grazing incidence spectrometer.

A steep increase in the total radiation power has been observed by the pyroelectric detector when a spontaneous transition to the ETB phase occurred, together with the abrupt change in spatial profile of radiation emissivity measured by the AXUV photodiode array. Although the transition to the ETB phase is accompanied by the formation of density pedestal near the edge, the steep increases in the impurity signals cannot be explained by the change in the electron density. Hence the buildup of impurity densities inside the ETB is suggested, which is verified by the temporal evolutions of the emissivity of metallic impurity lines.

The simultaneous realization of the ETB and the reheat mode has recently been found in a very high density ($\simeq 10^{20}$ m^{-3}) CHS plasma in which the maximum record of the stored energy ($\simeq$9 kJ) was achieved. The characteristic behaviors of impurities observed in this type of discharges will also be discussed in this study. In addition, comparisons with numerical simulations of impurity transport will be reported for the quantitative analyses since changes in metallic impurity transport inside the ETB are inferred from the observed VUV spectra.