§18. Spectroscopic Diagnostics of High-Density Hydrogen Plasmas Interacting with a Graphite Plate

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We are investigating the interaction between high-density hydrogen plasmas and a graphite plate by using a compact divertor simulator excited by helicon-wave discharge.[1,2] In this year, we employed laser-induced fluorescence spectroscopy for measuring densities of CH, C_2, and H in high-density hydrogen plasmas (the divertor simulator) interacting with a graphite plate. In addition, we compared the temporal variation of the emission intensity of CH from LHD with that of the electron density.

Figure 1 shows an experimental result obtained by using the divertor simulator, and represents the relationship between the densities of CH and H radicals and the H_2 gas pressure, together with the pressure dependence of the electron density. CH radical is one of products of the interaction between hydrogen plasmas and the graphite plate. The electron density decreased monotonically with the gas pressure, while the CH radical density was roughly constant at a pressure range of $40<P<80$ mTorr. This result suggests that simple physical sputtering by the irradiation of positive ions to the graphite plate is not the principal production mechanism of CH, and some chemical processes may contribute to the production of CH. On the other hand, the H radical density increased with the gas pressure at $40<P<70$ mTorr. Hence, it is supposed that chemical etching effect, in which H radicals participate, is a major production process of CH. Another experimental result shown in Fig. 2 also indicates the importance of chemical processes for the production of CH. This result was obtained at a fixed discharge condition by changing the temperature of the graphite plate. In this case, it has been confirmed that the variation of the emission intensity represents that of the radical density. As shown in the figure, the CH density increased with the graphite temperature, while we observed the decrease in the emission intensity of H, suggesting that H atoms react with the graphite plate to produce CH radicals.

Figure 3 shows the temporal variations of the emission intensity of CH and the electron density observed in an LHD discharge. As shown in the figure, the emission intensity of CH followed the electron density. If the variation of the electron temperature is neglected, the CH radical density is proportional to the emission intensity divided by the electron density. Hence, according to the experimental result shown in Fig. 3, the CH radical density may be independent of the electron density, suggesting the contribution of chemical processes to the production of CH in the LHD discharge.

References
1) H. Yamaguchi, S. Sobhanian, M. Goto, S. Morita, K. Kawahata, and K. Sasaki: Jpn. J. Appl. Phys. 42 (2003) 7080.
2) M. Aramaki, K. Kato, M. Goto, S. Muto, S. Morita, and K. Sasaki: Jpn. J. Appl. Phys. 43 (2004) 1164.

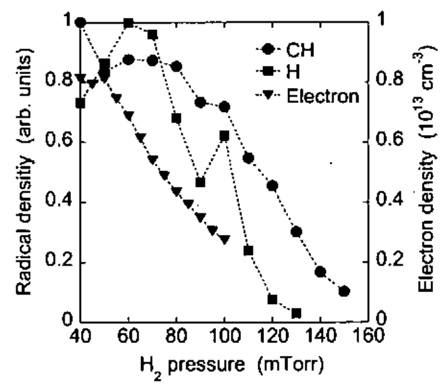

Fig. 1 Pressure dependences of the CH radical density, H radical density, and the electron density observed in a compact divertor simulator.

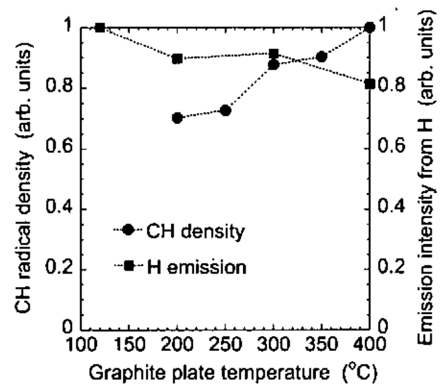

Fig. 2 The CH radical density and the emission intensity of H (the H radical density) as a function of the temperature of the graphite plate.

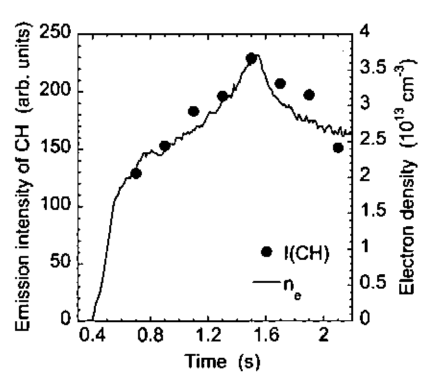

Fig. 3 Temporal variations of the emission intensity of CH and the electron density observed in an LHD discharge.