§1. Production Mechanism of Impurity Hydrocarbons and their Transportation in LHD Plasma

Kusakabe, T. (Kinki Univ.), Furuya, K. (Kyushu Univ), Kitajima, M. (Tokyo Inst. Tech.), Imai, M. (Kyoto Univ.), Motohashi, K. (Toyo Univ.), Igarashi, A. (Miyazaki Univ.), Pichl, L. (ICU), Sawada, K. (Shinshu Univ.), Kato, D., Sakaue, H.A., Morita, S., Goto, M.

In current large devices of the controlled thermo-nuclear fusion, it has been known that various types of impurity molecules are existed in edge and divertor plasmas, and these impurities should play as “poisons” for plasma hence degrading the plasma quality and properties. In the LHD plasma, the evidence of the production of various hydrocarbon impurities is also revealed from the observation of CH-spectrum. Therefore, it is essential for production of high-quality plasma and excellent plasma control to understand the production of these impurity molecules, interactions of these molecules with plasma and their transportation and behavior inside plasma. In addition, it has been widely utilized these molecular species as the probe of plasma analysis and diagnostics.

We have initiated this organized joint effort by gathering top-level scientists in the fields of the atomic, molecular, material, and plasma sciences to shed much light on these entire processes of impurities comprehensively. As the first and second years of this project, we focused on two subjects, that is, to understand impurity molecule production at divertor, and their interactions with plasmas (electron, proton and other ions). In third year of this project, we have continued these studies with some new progressive subjects, and prepared to construct the first version of hydrocarbon transport code for the LHD plasmas. In the forth year of this project, we worked the summary of the results of this research obtained until now. Some studies were continued to get fully results, and hydrocarbon transport code for the LHD plasmas has been constructed successfully.

The experimental group for electron collisions has developed a new set-up for the ultra cold electron collision experiment utilizing the threshold photoelectrons. In the preliminary experiment with an attenuation method, the total cross sections of cold electrons are successfully measured in collisions with Kr and Xe atoms, and N_2 and CO_2 molecules in the collision energy range of 10 meV and 12 eV. As shown in Fig. 1, the Feshbach resonance is firstly observed for the total cross sections of Kr and Xe atoms as well as the Ramsauer minimum.[1] The shape resonance is also observed for the total cross sections of N_2 and CO_2 molecules. This measurement will be continued for CH_4 molecules.

The experimental group for plasma science has researched deeply on the gaseous phase molecular growth in the downstream region of Ar/CH_4 plasmas. Mass resolution of experimental set-up for this research was remarkably improved. New experimental results were presented at the 57th Spring Meeting, 2010 (The Japan Society of Applied Physics).[2]

The simulation group for plasma science has constructed the first version of hydrocarbon transport simulation code for the LHD plasmas, and calculated the density distributions of various hydrocarbon molecules and ions generated from methane or acetylene molecules (see in Fig. 2). These results were presented at 26th Annual Meeting of The Japan Society of Plasma Science and Nuclear Fusion Research.[3]

We have observed several new insights in these projects and will be reported and published successively.

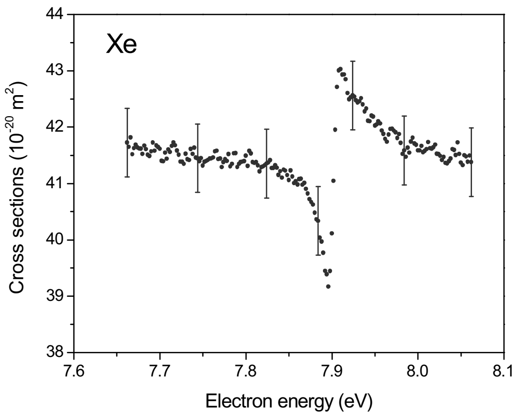

Fig. 1. Total cross section for Xe at around of Feshbach resonance.

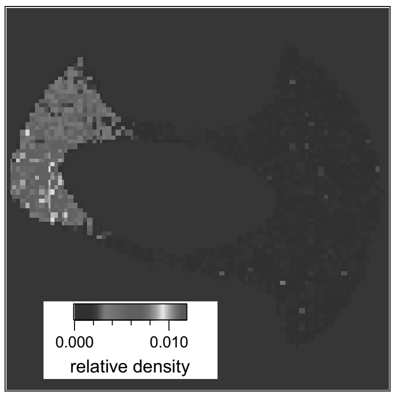

Fig. 2. Density distribution of CH molecules produced from CH_4 molecules.

1) Kurokawa, M., Kitajima, M. *et al.* : J. Phys.: Conf. Ser. **194** (2009) 042010.
2) Furuya, K. *et al.* : The 57th Spring Meeting, 2010 (The Japan Society of Applied Physics) Kanagawa, (2010) 17p-ZC-7
3) Yamaguchi, N., Sawada, K., Nakamura, H., Ito, A., Goto, M. : 26th Annual Meeting of The Japan Society of Plasma Science and Nuclear Fusion Research, (Kyoto) (2009) 2aD16P.