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

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In controlled thermonuclear fusion rectors, it has been known that various types of impurity molecules are produced near divertor edge, and these impurities should play as poisons for plasma hence degrading the plasma quality and other plasma properties [1]. Therefore, it is essential for production of high-quality plasma and excellent plasma control to better 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.

Therefore we have initiated this organized joint effort by gathering top-level atomic and molecular scientists, material scientists and simulation scientists to shed much light on these entire processes of impurities comprehensively. As the first year of this project, we have specifically focused on two subjects, that is to understand (i) impurity molecule production at divertor, and (ii) their interactions with plasmas (electron, proton and other ions). For (i), we employed primarily theoretical means to obtain some insights on molecular formation mechanisms and their yields near carbon-walls as well as formation rates. By ion impinging on adsorbed atoms and molecules, differences and similarities of mechanisms for ionization and charge transfer depending upon kinds of species of surface adsorbed particles as well as surface materials have been investigated systematically. For (ii), it has been known that charge transfer processes of slow H^+ ions in collisions with impurity molecular below a few-keV energies play a key role in low temperature edge plasmas. However, very little experimental and theoretical investigation has been carried out. Hence, we undertook a joint study with experimental and theoretical groups to look into various types molecular targets and to extract some guidelines to derive a unified scaling rule for charge transfer and ionization for molecular targets. Also, under the usual operational condition of fusion reactors, most of molecular species are in vibrationally excited states, or for some cases, even in electronically excited states. Therefore, it is very important to consider these physical parameters to evaluate ionization and charge transfer cross sections. We have undertaken an investigation charge transfer cross sections of $H^{+,}$ C^+ and O^+ ions colliding with vibrationally ground as well as excited hydrocarbons C_mH_n (m < 4) molecules in the energy range of 0.2 to 4.0 keV in collaboration with Prof. Buenker at U. Wuppertal. [2 –3].

We have observed several new insights in these projects and have reported.

References

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