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Research on hydrogen compound gas decomposition using helium RF plasma

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1. Introduction

In nuclear fusion technology, the exhaust gas from a fusion reactor contains three types of gases; unburnt fuel gases (D and T), fusion reaction product (He) and other impurities. The impurities are hydrogen compounds (water vapor, methane and etc.) and rare gases for cooling plasma edge (Ne and Ar). The exhausted gases from reactor must be refined before sending to an isotope separation system (ISS).

In the previous study, we investigated a flow-type plasma reactor using Radio-frequency (RF) plasma to examine the decomposition of methane[1-3]. Monte Carlo simulation was used to evaluate the atoms and molecules collision processes[4]. Because the electron collision with methane is important in this decomposition method, we evaluated the electron-methane collision process, considering the dependence of electron energy and mean free path.

2. Experiment

According to the past experimental apparatus[5], in this study, we investigate the electron density and the distribution in the cylindrical chamber. A Langmuir probe was inserted into the chamber in order to measure electron density. The chamber had 3 ports which the probe can be inserted, in the cylindrical side. In the cylindrical bottom, the flange connected to the quadrupole mass spectrometer (QMS) was exchanged to the flange where the probe can be inserted. By shifting the tip of the probe, the radial and longitude distribution of electron density were measured. The radial distribution was almost uniform. On the other hand, the longitudinal distribution was proportional to the gas inlet position.

3. Result and discussion

The electron densities were measured from ports 1, 2 and 3 at the RF powers of 10 ~ 60 W under the total pressures of 200 ~ 2000 Pa. It was found that the electron density is proportional to the RF power and independent to the total pressure. The dependence of electron density on the RF power and the total pressure is consistent with the value of $k_{decomp}V$. This means that the $k_{decomp}V$ was related to the electron density. From this investigation, proportional coefficients P_0 [1/(m^3·W)] at each port were obtained. The proportional coefficient at port 2 was 1.29 ×10^{13} 1/(m^3·W). Fig. 1 shows the electron density distribution calculated from the derived equations.

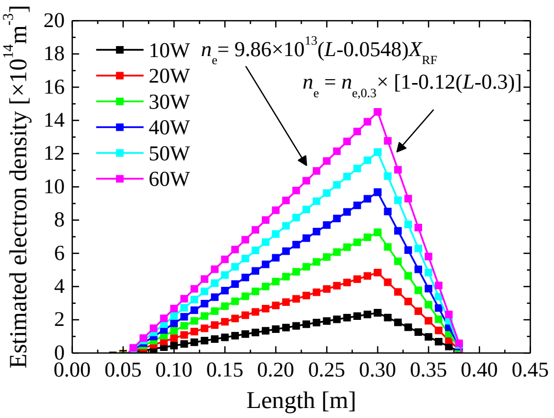

Fig. 1 The electron density distribution in the plasma reactor evaluated based on the Langmuir probe measurements.

Reference

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