Extraction of Negative Hydrogen Ions through a Plasma Electrode Covered by a Ta or Ti Foil

1Kenta Maesho, 1Motoi Wada, 2Shingo Masaki
1Graduate School of Science and Engineering, Doshisha University, Kyoto, Japan
2SOKENDAI(The Graduate University for Advanced Studies), Tokyo, Japan

INTRODUCTION

Negative hydrogen ion (H\textsuperscript{−}) current and electron current extracted from a negative hydrogen ion source differ under various conditions. Changes in the plasma electrode bias depend on the material used in the plasma electrode surface. Using Ta filament as the hot cathode in a negative ion source improves hydrogen ion production [1]. Ta vapor deposition on the plasma electrode surface may absorb more efficiently the hydrogen ions, which destroy the negative hydrogen ions by associative detachment [2]. Titanium (Ti) and Ta alloys also absorb hydrogen atoms in high temperatures [3]. This study aims to verify Ta cathode effectiveness in a negative hydrogen ion source by comparing Ta and Ti foils.

EXPERIMENTAL SETUP

EXTRACTION EXPERIMENT

- Ta filament operation increases extracted negative hydrogen ion current (22% higher against W filament operation).
- Ta foil on a PE has an effect of improving the ratio of $I_{H^-}/I_{base}$.
- Though Ti foil shows the higher ratio of $I_{H^-}/I_{base}$, absolute amount of $I_{H^-}$ was lower than other operations.

PHOTODETACHMENT EXPERIMENT

- In Ta filament operation, both probe current at 12 V ($I_{probe}$) and probe current increment at photodetachment are larger than W filament burning.
- Ta filament operation improves negative hydrogen ion production (about 88% higher than W filament operation).
- Ti foil has an effect to decrease negative hydrogen ion density (about 69% lower than W filament operation).

Ta covering the plasma electrode surface enlarges negative hydrogen ion current. A hot cathode made of Ta increases the density of negative hydrogen ion in a negative ion source. Ta foil on a plasma electrode makes negative ion current – electron current ratio larger by 13%. At Ta filament operation, increment of negative ion density against W filament without foil operation (88%) is larger than the increment of negative ion current (22%).

PROBE EXPERIMENT

- The effects due to the change of filament and PE materials appeared most pronounced in electron density.
- Plasma grid bias effect appears small because the large distance between the PE and the Langmuir probe.
- Ta and Ti foil operation slightly decreased the electron temperature.

SUMMARY

REFERENCE