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Spectral Intensity Distribution in VUV Range Around a Hot Cathode in a Hydrogen Discharge

水素放電熱陰極近傍プラズマの VUV 発光スペクトル分布

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Vacuum ultra violet (VUV) emission had been investigated for plasma close to the discharge filament cathodes to observe photon emission associated with production of vibrationally excited molecules (H_{2v}^*) formed from electronically excited hydrogen molecules produced by high speed electrons released from a tungsten filament cathode. The position of the filament can be changed during discharge operation to charcterize spatial distribution of formation rate of H_{2v}^*. The spatial distribution of VUV signal can be utilized to obtain mean free path of electronically excited molecules, when it is coupled to the distribution of high energy electrons.

1. Introduction

The so called electron volume process of negative hydrogen ion (H^-) production requires the presence of vibrationally excited hydrogen molecules (H_{2v}^*) in the plasma. The production rate of these molecules can be correlated to vacuum ultra violet (VUV) emission from the plasma, while these molecules have to be transported to the extraction region of the ion source to form H^-. Namely, the smooth transport of H_{2v}^* is desirable. In this report, we investigate the H_{2v}^* formation rate near the filament utilizing VUV spectroscopy to evaluate the possibility to optimize H^- yield by arranging the positions of discharge filaments.

2. Experiment system

The schematic illustration of the ion source used in the current experiment is given in Fig. 1. This ion source has a cylindrical shape of 160 mm diameter and 300 mm length. Sixteen rows of Sm-Co magnets surround the ion source wall and form the magnetic multicusp fields. One of the end flange is equipped with Sm-Co magnets, while the other on is electrically isolated from the side wall, or kept at the floating potential during plasma operation.

A 0.3 mm diameter 80 mm long tungsten filament serves as the cathode of discharge. The filament is mounted on a linear motion feed through to change the position in vacuum during plasma operation. There is another tungsten filament of the same design is inserted into the source at the fixed position to work as the auxiliary cathode. This filament is located far from the line of sight of VUV light emission observation.

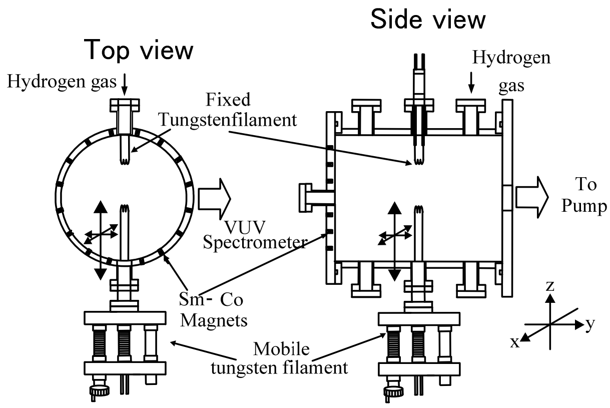

Fig. 1. Schematic of a negative ion source

3. Typical VUV spectrum.

In Fig. 2 is shown a typical VUV spectrum emission near the center of the plasma excited with the auxiliary filament. The relative intensity of the band spectrum integrated over the wavelength range corresponding to Werner and Lyman bands is utilized as the quantity proportional to the production rate of H_{2v}^*.

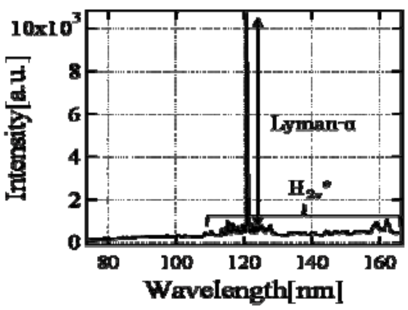

Fig. 2. Typical VUV spectrum observed at the position far from the tungsten filament cathode.