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小型ECR源を用いた負イオン表面生成特性評価

Evaluation of H$^-$ surface-production characteristics using a compact ECR source

桑原大典[1], 粕谷俊郎[1], 笹尾真実子[2], 和田元[1]

D. Kuwahara[1] , T. Kasuya[1] , M. Sasao[2] and M. Wada[1]

[1] 同志社大学大学院理工学研究科

[2] 同志社大学研究開発推進機構

[1] *Graduate School of Science and Engineering, Doshisha University, Kyoto, 610-0321, Japan*

[2] *Office of R&D Promotion, Doshisha University, Kyoto, 602-8580, Japan*

1. Introduction

Negative hydrogen ion (H$^-$) current from an ion source can be enhanced by introduction of Cs into the ion source [1]. Work function of the plasma grid was confirmed to be an important parameter for H$^-$ production [2,3], while the plasma grid temperature is affected the H$^-$ production: the work function decreased with the increasing negative ion current [4]. Correlation between the H$^-$ current and the temperature showed characteristics difference depending upon the material covering the plasma grid surface [5]. These observations suggest that the Cs adsorption on the surface depends on both the surface temperature and the base material; surface work function changes depending upon the plasma grid material and the temperature. In other words, the ion yield can be optimized by controlling the plasma grid temperature. However, precise control of the plasma grid temperature is difficult under plasma irradiation condition because the plasma grid is usually too thin to install temperature controlling components. It is difficult to replace plasma grids for the test ion sources of large scale fusion relevant projects and the effectiveness of an active control of the plasma grid temperature is tested in a laboratory experiment.

2. Experimental system

Figure 1 shows the schematic diagram of the setup used to measure the surface temperature effect upon negative hydrogen ion production. The test apparatus was equipped with a compact ECR ion source which does not contaminate the grid surface by the electrode sputtering. The low work function surface converts incident hydrogen ions into negative ions by surface negative ionization. These ions are extracted by extraction voltage and detected by a Faraday cup behind the target holder. The work function measurement employs several wavelength lasers (325 nm, 405 nm, 450 nm, 532 nm and 650 nm) and produces the signal values of the quantum efficiency Y which is defined by the number of the emitted photoelectrons per the number of the absorbed photons.

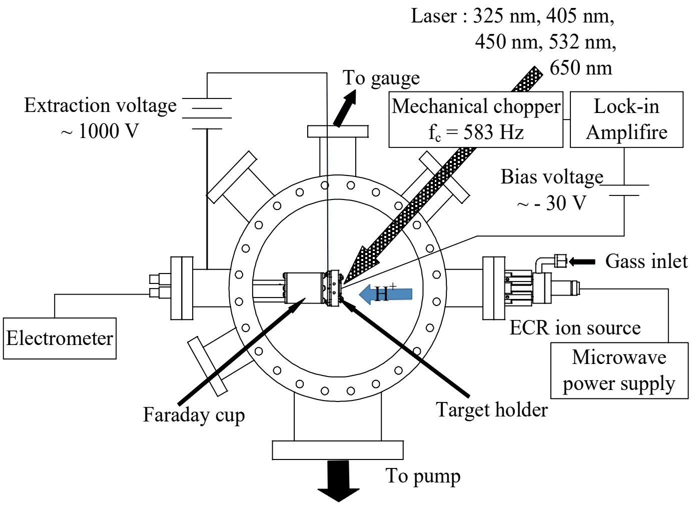

Fig. 1. Schematic diagram of the measurement setup.

3. Low work function surface

Bi-alkali (Cs-K) on Mo surface realizes a low work function surface. It is expected that Bi-alkali surface has minimum value of work function depending upon the temperature. The heater attached at the target holder maintains the target temperature by heater power control. The correlation between the target temperature and work function, and that with the negative ion yield are measured. Figure 2 shows the typical result of the photoelectric current measurement using bi-alkali surface. According to the Lange's theory [6], quantum efficiency is expressed in the following formula near the threshold of work function.

$$Y \propto (h\nu - \Phi_w)^n$$

By choosing $n = 2$ and plotting Y as a function of photon energy, approximation curve indicated that work function of this target was about 2.2 eV.

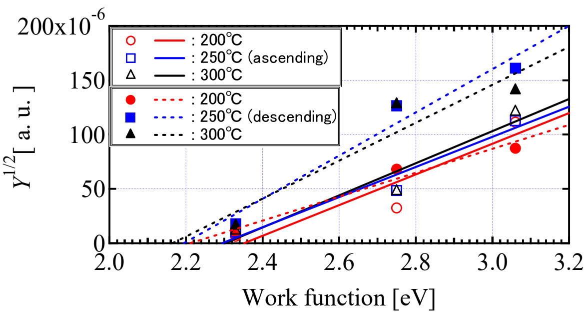

Fig. 2. Square root of the quantum efficiency plotted as a function of photon energy.

4. Reference

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