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Plasma-Surface Interaction in Negative Hydrogen Ion Sources

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Fundamental data are indispensable to set up a numerical simulation model to predict the amount of current extracted from an ion source. Surface recombination process plays a decisive role for determining the proton ratio in hydrogen plasma ion species, and the data on recombination coefficients have been accumulated for elements used for ion source wall materials [1]. The surface conditions of ion sources, however, are usually far from ideal ones composed of pure metals with hydrogen in ultra-high vacuum environment in which most of the plasma-surface interaction data are collected. For example, a plasma grid of a negative hydrogen (H^-) ion source adsorbs Cs and hydrogen, but the co-adsorption process data obtained in ultra-high vacuum environment [2] cannot be utilized as plasma wall interaction can contaminate the plasma grid surface.

This study aims at finding the plasma-surface interaction process influential on H^- ion source performance. A small ion source sealed with copper gaskets was designed and assembled to study plasma-surface interaction in a H^- ion source. Ports for residual gas analysis, optical emission spectroscopy, Langmuir probe measurement, and laser injection for photodetachment together with adsorbate material ablation are integrated into the source. A high temperature tungsten capillary tube forms a directed beam of atomic hydrogen to see the contribution to the extracted H^- ion current. Effect on Cs accumulation on the plasma grid due to temperature distribution over the inner wall of the ion source is estimated with an infrared thermography.
Addition of foreign materials into the source will alter plasma-surface interaction in the vicinity of the plasma grid. Oxygen or water injection into the test ion source should form oxides on the surface of the plasma grid and may decrease H^- ion emission. Carbon coating on a pure metal substrate can increase/decrease surface work function and sticking probabilities of the grid surface against hydrogen atoms and molecules. Resulting change in extracted H^- ion current together with co-extracted electron current are discussed.

References

[1] B. J. Wood, H. Wise, J. Phys. Chem. 65, 1976(1961).

[2] C. A. Papageorgopoulos and J. M. Chen, Surf. Sci. 39, 283 (1973).

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