§11. Angular Resolved Energy Distribution Functions of Low Energy Light Atoms Reflected at a Low Work Function Metal Surface

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The electron attachment process at a low work function metal surface can be utilized to make a negative ion source of He. The surface process should be a better alternative to the double charge exchange process for making an intense He^- beam source of the fusion product measurement system, provided both the angular distribution and the energy distribution of surface produced He^- are narrow enough. A system capable of measuring the angular resolved energy distribution function of the surface produced He^- ions is being developed aiming at the compilation of data necessary to determine which type of ion source is more suitable for the fusion product diagnostic system.

The assembled system is schematically shown in Fig. 1. The system is composed of three chambers with a positive ion source. Positive ions of 0.5 to 3 keV energy are neutralized with a neutralizer gas cell, and the ions are removed by magnetic field produced with a pair of permanent magnets. The beam intensities are measured with a Faraday cup and a pyroelectric caloriemeter. The target is positioned in front of a magnetic-deflection-type-momentum-analyzer inserted from the target preparation chamber in which the target surface is cleaned with ion bombardment and covered with Cs layer with a Cs evaporator.

For each incident beam angle, the energy distribution function is obtained by scanning the intensity of the magnetic field of the analyzer with a controlling electronics. The measured positive ion spectra obtained by injecting He neutrals shows the energy spread as large as several hundred volts. The peak of the angular distribution shows a distinct shift toward the direction of the surface normal. This is shown in Fig. 2. The integrated intensity of He^+ produced by scattering of neutral He striking the surface with 10 degree angle from the surface takes a maximum at 35 degree exit angle instead of 20 degree corresponding to the mirror reflection.

The effect of the Cs coverage shows a pronounced change in charge state of the reflected particles. When Cs covers the Mo surface, no signal of the positive ion is found present in the momentum spectrum. This corresponds to the efficient electron transfer from the surface to the positive ions escaping from the surface. Under this condition, negative ionization efficiency must be high and He^- should be produced at the surface. The detection efficiency of the present system is a little too small to distinguish the He^- energy spectrum from the background noise. With a small sacrifice in the angular resolution, the efficiency can be made enough to conduct the measurement for He^- [1]. In addition to the experiment to study the fundamental process of surface negative ion formation, the system can be utilized for the plasma-high Z wall interaction with hydrogen ion beams [2].

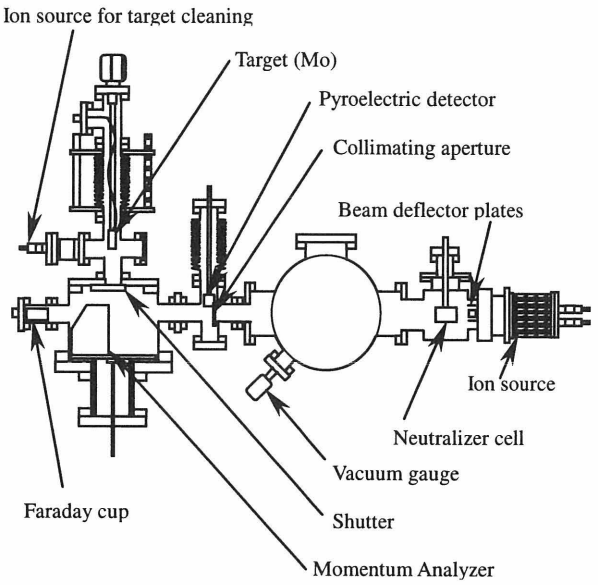

Fig. 1. Schematic diagram of the experimental apparatus.

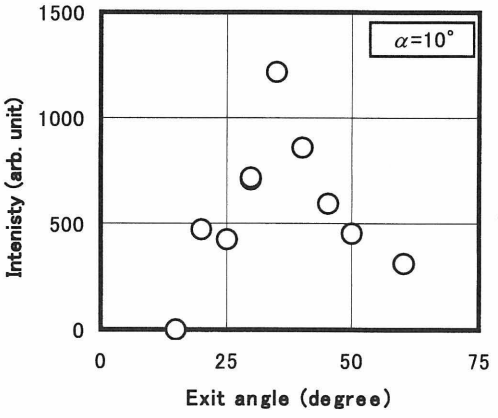

Fig. 2. Angular distribution of total He^+ ion current produced from He^0 injection onto a Mo target surface.

References

[1] M. Wada, M. Sasao, M. Nishiura, Y. Matsumoto, H. Yamaoka, K. Shinto, Rev. Sci. Instrum. **73**, 955 (2002).
[2] E. Vietzke, M. Wada, M. Hennes, J. Nucl. Mater. 266-269, 324 (1999).