§11. Measurement of Angular Resolved Energy Distribution Function of Particles Reflected at Refractory Metal Surface

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Particle reflection coefficients and energy reflection coefficients are important parameters determining edge plasma characteristics of fusion devices. Also important in setting up a proper model of plasma transport in divertor region is the charge state distribution of reflected particles. A setup was assembled to measure negative ionization coefficients of light ions at refractory metal surface.[1] The system was modified to measure angular resolved energy distribution functions of ions to yield fundamental data for plasma wall interaction in fusion devices.

The experimental system is schematically illustrated in Fig. 1. A mass separated beam from the ion source are directed to the target through collimating apertures. The incident angle of the beam onto the target surface, α, can be adjusted by rotating the target. The exit angle, β, is chosen by rotating the entire body of a 90° bending magnetic momentum analyzer. Particles having a proper linear momentum chosen by the magnetic field of the analyzer pass through two collimators before they hit the front surface of a multi channel plate detector. Signals are detected with a counting mode, while energy spectra of the detected beam can be recorded by sweeping the field strength of the momentum analyzer.

Modifications were made to test refractory metal surfaces after cleaning inside of the vacuum chamber with ion beams. Experiment to measure ionization coefficient out of incoming neutral atoms was also made possible by installing a gas neutralizer cell. The intensity of the produced neutral beam can be measured by a pyroelectric neutral particle detector.

Results obtained with C covered Mo surface were unstable as the incident beam decreased the coverage of C. Similar change of surface condition due bombardments of incident H^+ and H^0 onto Cs covered Mo for negative ionization was found. In these experiments, the energy at which the energy spectrum of positive ions produced by reflection at the surface took the maximum was found higher than that of negative ions. A precise calibration of energy spectrum was made by directly putting in the beam into the momentum analyzer.

The measured spectra after the calibration had actually shown the difference in energy spectrum of negative ions from that of positive ions for clean Mo surface. The tendency of the energy spectra are show in Fig. 2, which also shows the angular distributions of the reflected beams are also similar for positive and negative ions. Measured angular resolved energy spectra from clean Mo surface showed little difference against the charge state of incident particles.

The present goal of the research is to obtain data for incident ions and neutrals of energy lower than 1 keV, which are considered important in plasma wall interaction in fusion devices. The present problem in at low incident particle energy is the unknown efficiency of the front surface of the multi-channel detector. Particle reflection data of H^+, H^-, H_2^+, H_3^+, and impurity ions like He^+, O^+ and C^+ will be measured with the experimental setup.

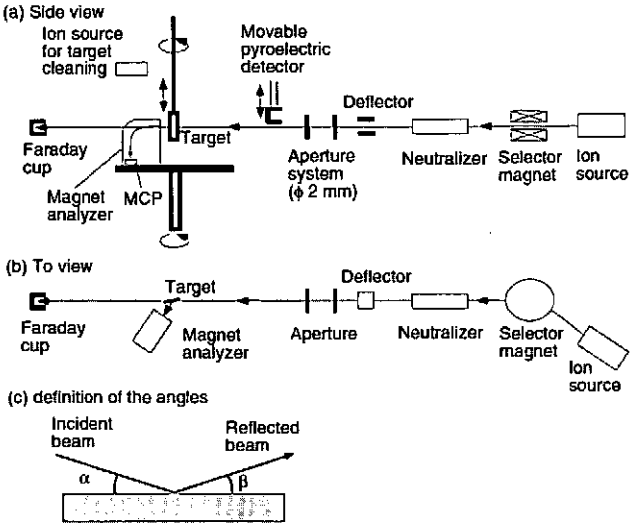

Fig. 1. Schematic diagram of the experimental setup with definitions of incident and reflection angles.

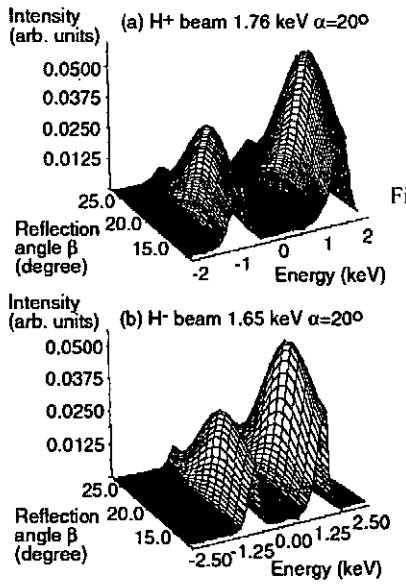

Fig. 2. Examples of energy and angular resolved intensity profiles of H^+ and H^- ions reflected from Mo surface at the incident angle of 20*o* for (a) H^+ and (b) H^- beam injection.

References

1) M. Wada, M. Sasao, M. Nishiura, H. Yamaoka and Y. Matsumoto, *Rev. Sci.Instrum.* **73** (2002) 955.
2) M. Sasao, Y. Matsumoto, A. Mendenilla, M. Nishiura, K. Shinto, M. Wada and H. Yamaoka, *Proc. 30th Euro. Phys. Soc. Conf. on Contr. Fusion and Plasma Phys.* (St. Petersburg, July 2003) **Vol. 27A** P-2.161