Dynamics of proton desorption from solid surfaces excited with slow multi-charge ions

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When a slow multi-charge ion (MCI) approaches to a solid surface, desorption or sputtering from the surface occurs. It is generally considered that charge exchange between the surface atoms and the MCI acts an essential role in the processes. Actually, some papers reported the small derivative as well as the large abscissa in the kinetic energy dependence of the sputtering yield. This means that the dominant process is not kinetic sputtering (KS) but potential sputtering (PS) [1]. According to the author's knowledge, however, there was no data on the dynamics of the PS. The information about kinetic energy and angular distribution of the secondary ions in the PS is necessary to understand the atomic processes.

Coincidence measurements between scattered ions and secondary ions were conducted to study the dynamics of PS induced by slow MCI [2]. The experimental set up is schematically shown in Fig. 1. The mass to charge ratio of a secondary ion was analyzed by a time-of-flight secondary ion mass spectrometer (TOF-SIMS). The kinetic energy and the charge state of a scattered ion were analyzed by an $E \times B$ energy analyzer and a parallel plate, respectively. A two dimensional position-sensitive detector (2D-PSD) makes it possible to measure the kinetic energy and the charge state of the scattered ion simultaneously by the longitudinally dispersing position image as shown in Fig. 1. The time difference between the secondary ion detected with the TOF-SIMS detector and the scattering ion detected with 2D-PSD as well as the position data (y, z) of the scattering ion were recorded by a digital oscilloscope, event by event.

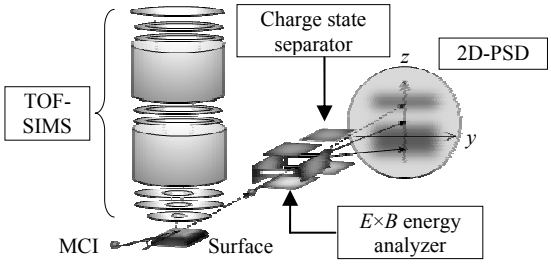

Fig. 1. The schematic illustration of the experimental set up.

Fig. 2 shows the kinetic energy distribution of protons emitted from a GaN(0001) surface interacting with slow (375 eV/u) Ar^{6+} ions. Note that these data were recorded only when Ar^{+} ions hit the 2D-PSD. Generally speaking, the velocity of scattered ion changes due to collisions with the surface atoms. Thus, the time difference between secondary ion and scattered ion involves time delay due to the energy loss of scattered ion. However, the TOF of the scattered ion was simply transformed by the kinetic energy measured with the $E \times B$ energy analyzer in this study. As a result, the kinetic energy distribution of the secondary protons was successfully measured. This is the first kinetic energy measurement of secondary ions originating from "pure PS" induced by MCI.

The preliminary results of other solid surfaces will be presented in this conference.

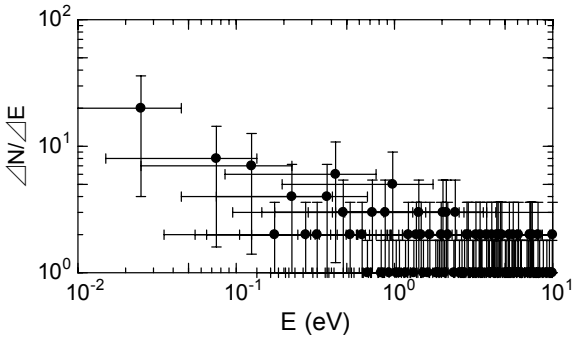

Fig. 2. Kinetic energy distribution of secondary protons.

References

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[2] K. Motohashi, J. Phys. Conf. Ser., **194**, 012061 (2009)