§13. Angle-resolved Intensity and Energy Distributions of Positive and Negative Hydrogen Ions Released from W Surface by Molecular Hydrogen Ion Impact

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Hydrogen ion reflection properties have been investigated following the injection of H^+, $H_2{}^+$, and $H_3{}^+$ ions onto a polycrystalline W surface. [1] Angle- and energy-resolved intensity distributions of both scattered H^+ and H^- ions are measured by a magnetic momentum analyzer. The reflected hydrogen ion energy is less than one-third of the incident beam energy for $H_3{}^+$ ion injection and less than a half of that for $H_2{}^+$ ion injection. Other reflection properties are very similar to those of monoatomic H^+ ion injection.

Figure 1 shows two-dimensional (2-D) contour intensity map of the reflected positive and negative atomic ions scattered from the W surface as a function of the incident angle (α) and reflected angle (β) following H^+, $H_2{}^+$, $H_3{}^+$, and He^+ ion beam injections. Solid lines correspond to the specular reflection, where $\alpha = \beta$. The intensities of reflected positive hydrogen ions are usually higher than those of negative hydrogen ions in the incident energy range less than 3 keV. At a low incident angle the intensity of the reflected ions takes the maximum around the mirror angle for particle reflection. However, the angle at which the reflected particle takes the maximum deviates from the mirror reflection angle for a larger incident angle of incoming hydrogen ions.

Classical trajectory simulations using the Monte Carlo simulation code ACAT based on the binary collision approximation are performed. Simulation results of the reflection energy distribution as a function of the reflection angle are shown in Fig. 2(a). Figure 2(b) shows 2-D contour intensity map from the results of ACAT calculations for the reflected particles. In Fig. 2(b) we show the experimental result again for the scattered H^+ ions following 2 keV H^+ ion injection. Solid lines correspond to the specular reflection. The ACAT simulation does not reproduce the experimental results well, although it shows a similar trend.

1) S. Kato *et al.*, *J. Nucl. Mater.* **463**, 351 (2015).

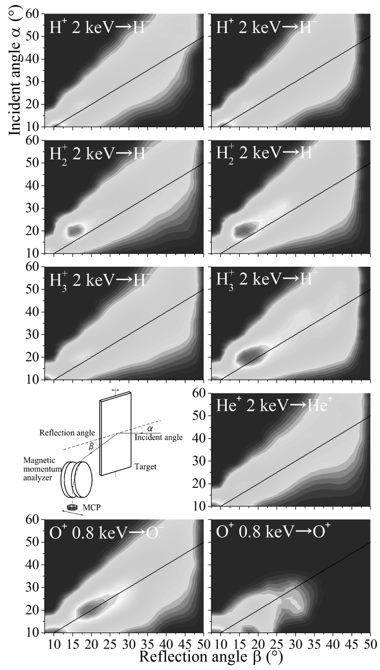

Fig. 1: 2D intensity map of the incident and reflection angle dependence of the H^+ and H^- ion intensity from W surface for H^+, $H_2{}^+$, and $H_3{}^+$ beam injections. The incident beam energy is 2.0 keV. The intensity map for the 2 keV He^+ ion and 0.8 keV O^+ ion injection are also shown. Solid lines correspond to the specular reflection. Definition of the incident (α) and scattered (β) angles is shown in the figure.

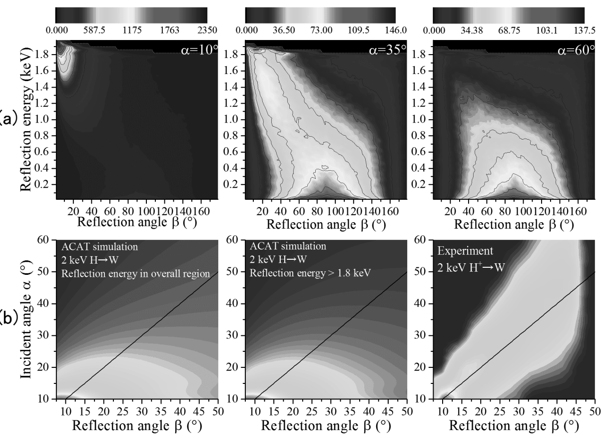

Fig. 2: (a) ACAT simulation results of the reflection intensity of neutral particles injected at $\alpha = 10°$, $35°$, and $60°$. (b) Contour intensity maps from the ACAT simulation for the reflected neutral particles in all reflection energy range and in the energy range more than 1.8 keV, respectively. Intensity map from the experimental result for the scattered H^+ ions following 2 keV H^+ ion injection is also shown.