§15. Large Ion Yield in Hydrogen Scattering from a Graphite Surface

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Divertor is an important device for High-Z impurity control, He removal and a hydrogen recycling in plasma-confinement devices. The surface processes, especially charge transfer processes of incident particles and divertor surfaces, were not investigated so much. Recently, radiative decay from highly excited molecules formed in a recombination reaction of H^+ and H^- ions in divertor region may relax the energy of incident H^+ onto the divertor wall[1]. In this work we investigated some of the charge transfer processes in the collisions of hydrogen-ous ions at a graphite surface.

The experiment was done under following con-ditions. The energies of incident hydrogenous ions (H_n^+; n=1,2,3) are fixed 400eV, and their incident angles were 70°.

The angular distributions of scattered H^- and H^+ ions are indicated in Fig. 1. Both the ion yields are as one order high as those yields from metal surfaces. The figure shows the scattered H^- ions have the peaks at specular angle to the incident beam trajectries. On the other hand, the peaks in H^+ ions shift to lower scattered angle. This suggests that backscattering com-ponents are included in H^+ scattering process. Fig. 2 shows the ratios of scattered H^- ions to all the scattered particles. The distribution in every incident particle is almost flat. It is noticable that the ratios attain more than 10% of all the scattered particles.

The detail mechanizm of the large ion yields in such scattering events are not clear. The work function of graphite is about 5eV, so conventional theories of charge transfer cannot explain such H^- yields. A high yield of scattered O_2^- from Si(001) has reported by Rechtien and co-workers[2]. They explain this due to a electronic structure of Si. Graphite has a very low electronic density of states, so the large ion yields may be caused by this electronic structure.

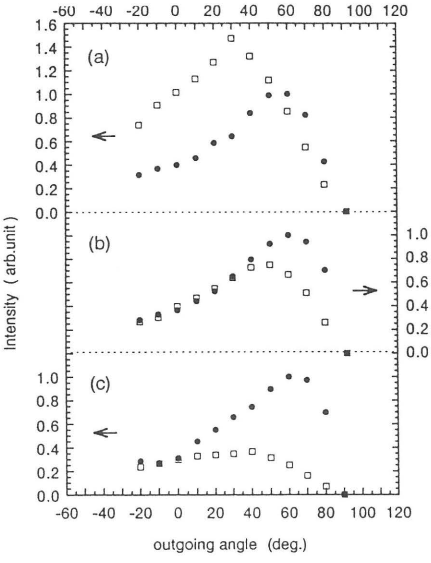

Fig. 1. Angular dependence of both scattered H^+ and H^- ions at peak positions for the incidence of protons (a), H_2^+ ions (b), and H_3^+ ions (c). Solid cirles indicate scattered H^+ ions and open squares indicate scattered H ions.

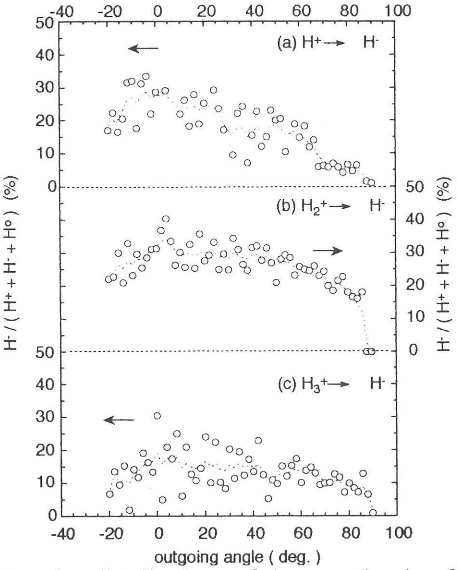

Fig. 2. Angular distributions of the negative ion fraction, which is defined as $\Phi H^- / (\Phi H^o + \Phi H_n^+ + \Phi H^-)$ with n=1,2 and 3, from a graphite surface resulting from the incidence of H^+ ions (a), H_2^+ ions (b), and H_3^+ ions (c). The energy and the angle of the incident proton beam are 400eV and 70°, respectively. Arrows indicate the corres-ponding fraction scales.

References

1) IAEA Advisory Group Meeting on "Atomic, Molecular and Particle-Surfafce Interaction Data For Divertor Physics Design Studies" 7-9 November, 1994, Vienna, Austria.
2) J.H.Rechtien, U.Imke, K.J.Snowdon, P.H.F.Reijnen, P.J.v.d.Hoek, A.W.Kleyn, and A.Namiki, Surf. Sci. 227, 35 (1990).