§15. Secondary Electron Emission by Low Energy Negative and Positive Ions

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Secondary electron emission(SEE) have been extensively studied for positive ion impact[1]. However, investigation of SEE by negative ion impact is scarce.

In this study, we have measured the SEE yield by H^- and D^- as well as H^+ and D^+ for C, Al, Si, oxides such as $SrCeO_3$ (5%Yb) and so on(uncleaned surfaces). Fig. 1 shows the energy dependence of the SEE yield per ion for carbon(reactor grade). The collector of secondary electrons and target were grounded, unless specified. When the bias of +22.5 V is applied to the secondary electron collector, the SEE yield is increased by a factor of 2-3 as shown by ▽(H^+) and ▼(H^-). This could be due to the fact that the detection efficiency of extremely low energy electrons is greatly improved by applying bias. The error of the SEE yields can be inferred from the scatter of the data points.

In the plot of the SEE yield vs E/u (energy per nucleon), we see that the SEE yields are nearly the same for H^+(o) and D^+(+), and for H^- (●) and D^- (x), for E/u > 0.1 keV/u. It is reminded that the electronic stopping power Se is almost the same for H and D at the same velocity, suggesting the Se proportional SEE yield which is valid for high energy ion impact. However, the SEE yield measured in this study does not follow the Se(shown by the dashed line)[2].

It is noticed that the SEE yield by negative ion impact is always larger than that by positive ion impact. This suggest that electrons in the negative ion contribute to the SEE. However, the kinetic energy of the electrons in the negative ion is so small to create electron cascades contributing to the SEE. The mechanism of the enhanced SEE by negative ion impact is to be explored. Emission of secondary ions and the energy distribution of the secondary particles are also to be investigated.

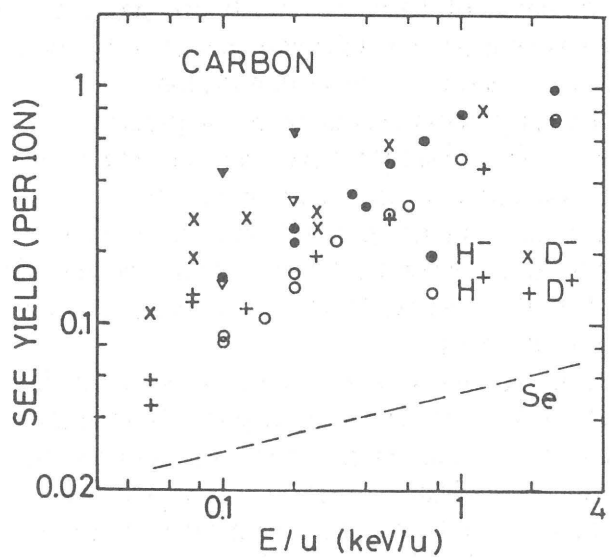

Fig. 1 SEE yield per ion from carbon (reactor grade) by H^- (●), D^- (x), H^+(o) and D^+(+) ion impact as a function of energy per nucleon. The SEE yield measured applying the bias of +22.5 V to the electron collector is shown by ▽(H^+) and ▼(H^-). The dashed line indicates the energy dependence of the electronic stopping power Se for H and D($Se=5.2\times10^{-15}$ eVcm^2 at 1 keV/u).

References

[1] E.W.Thomas, International Atomic Energy Agency, INDC(NDS)-322, IAEA, Vienna, Feb. 1995.
[2] J.F.Ziegler, J.P.Biersack and U.Littmark, The Stopping and Ranges of Ions in Solids (Pergamon, New York, 1985).