§12. Energy Loss Mechanism of a Gold Ion Beam on a Tandem Acceleration System

Taniike, A. (Grad. Univ. Advanced Studies)
Sasao, M., Fujita, J.
Wada, M. (Department of Electronics, Doshisha Univ.)

In order to study energy loss mechanism on a tandem acceleration system, a test stand has been constructed, and the charge state fraction, the beam profile and the beam energy spectrum of an Au^+ beam have been measured. The test stand consists of a negative gold ion source, a tandem acceleration system, a movable Faraday cup and an energy analyzer.

Figure 1 shows the dependence of the measured energy width on the impact energy, for target gases of He, Ar, Kr and Xe, under the condition that the charge stripping gas thickness is thin enough so that the two-electron stripping process is dominant and the multiple collision processes are negligible. The full width at half maximum is typically 20 to 80 eV, and it increases with the impact energy. In general, a broader width is observed with a target of a lower mass number.

A simple model is proposed using the semi-classical internal energy transfer function of Firsov's[1] and the scattering by the unified potential of Ziegler's[2]. In the limited region of the impact energy the theoretical prediction of the present model reproduces the energy and mass dependence of the broadening. However, the absolute values of the theoretically predicted width are much smaller than the measured widths. The present model predicts that the energy width saturates in the higher energy region less than 10 eV, and the target mass dependence disappears. In Fig. 2, solid curves indicate the calculated energy width convoluted by the energy resolution of the analyzer and the stability of the tandem accelerator power supply.

The energy broadening of an Au^+ beam produced by a tandem system can be estimated by the present theoretical prediction. Figure 2 shows the calculated charge fractions and energy width as functions of the target thickness at impact energy of 3 MeV for the Ar gas. The optimum gas thickness for Au^+ beam production is about 5×10^{14} cm^{-2}. Together with the energy broadening due to the multiple collision at this target thickness, the total energy width of the Au^+ beam produced by a tandem system might be less than several tens eV. It will be small enough for a HIBP diagnostics on LHD where the plasma potential is a few keV.

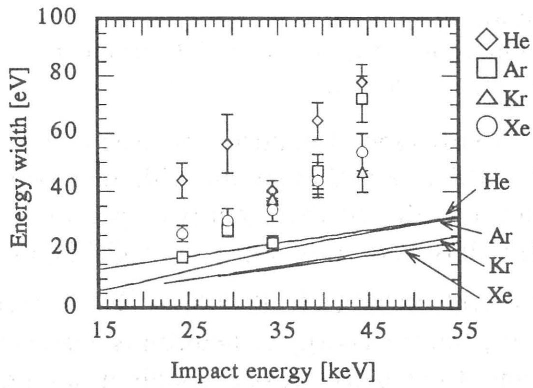

Fig. 1. The dependence of the measured energy width on the impact energy, for target gases of He, Ar, Kr and Xe. Solid curves indicate the calculated energy width convoluted by the energy resolution of the analyzer and the stability of the tandem accelerator power supply.

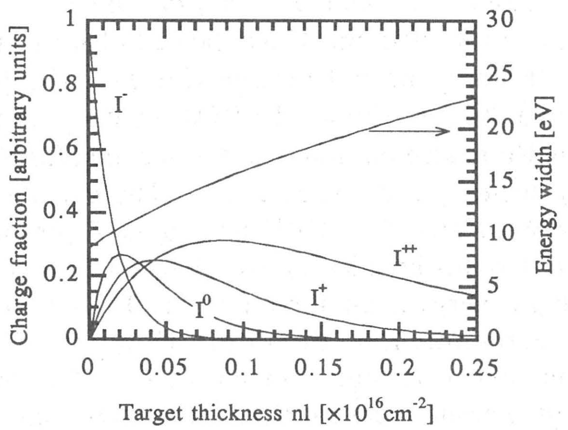

Fig. 2. The charge fractions and the energy width as functions of the target thickness at impact energy of 3 MeV for the Ar gas.

References
1) Firsov, O. B., Soviet Phys. JETP 9, 1076 (1959).
2) Biersack, J. P. and Ziegler, J. F., Nucl. Inst. Meth. 194, 93 (1982).