§8. Ejected Electron Spectroscopy in Electron-Ion Collisions

Sakaue, H.A., Yamada, I.,
Hirayama, T. (Rikkyo Univ.),
Ohtani, S. (Univ. Electro-Communications),
Sakurai, M. (Kobe Univ.)
Takayanagi, T. (Sophia Univ.)

The understanding of the interaction of electron-ion collision process is important not only for the control and diagnostic of plasma but also for the atomic physics at many atomic processes in high temperature plasma. The research of ionization process in the electron-ion collision had been done for a long time, and the data were offered to the plasma control, the diagnostics of plasma and so on. At present, however, there are few atomic data for the excitation processes of electron-ion collisions, because of its experimental difficulties such as a low signal-to-noise ratio due to a low target ion density and very small cross sections, etc.

So, we have started the systematic research of ionization and excitation processes in electron-ion collisions. This research aims at getting the detailed information of excitation processes from high resolution ejected electron spectroscopy and measuring the ionization cross section within errors of 1%. Presently, we reconstructed the high density ion source for the exclusive use of the electron-ion collision experiments and we developed the ejected electron energy analyzer which is electrostatic tandem type uniquely.

We show the experimental parameters which were achieved in the following.

Ion Beam:

Ar^+ I=340μA at 33keV, Kr^+ I=160μA at 33keV, Xe^+ I=40μA at 16keV, beam configuration 3mmϕ.

Electron Beam:

I=200μA at 500eV, beam configuration 15×3mm.

We fine-tuned the ejected electron analyzer by using the Auger spectrum at the electron atom collisions.

The spectra of LMM Auger at electron-Ar collisions are shown in figure 1-(a). The collision energy is 800eV and observation angle is 90 degree. These Auger electrons are emitted in following processes,

$$e + Ar \rightarrow Ar^{+*}(2p^5 3s^2 3p^6) + e + e$$
$$\mapsto Ar^{2+}(2p^6 3s^2 3p^4) + e_{ej}.$$

Then, Auger electrons of $L_3M_{2,3}M_{2,3}(^1D_2),(^3P_{0,1,2})$ are dominant. In figure 1-(b), we show the Auger spectrum of T.Kondow et al. [1] (E_e=860eV, θ=15°).

In figure 2-(a), we show the NOO Auger spectrum of electron-Xe collisions. The collision energy is 500eV and observation angle is 90 degree. These Auger electrons are emitted in following processes,

$$e + Xe \rightarrow Xe^{+*}(4d^9 5s^2 5p^6) + e + e$$
$$\mapsto Xe^{2+}(4d^{10} 5s^2 5p^4) + e_{ej}.$$ Line 12~19

Then, Auger electrons of $N_{4,5}O_{2,3}O_{2,3}$ are dominant. The line 7~11 are peaks of $N_{4,5}O_1O_{2,3}$ Auger processes. In figure 2-(b), the Auger spectrum of B.S.Min et al. [2] (E_e=500eV, θ=70°) is shown.

The resolution of our spectrum is not good rather than other one. From now on, we will have to improve the resolution of our spectrum. Then we will proceed with the research of the electron-ion collision processes

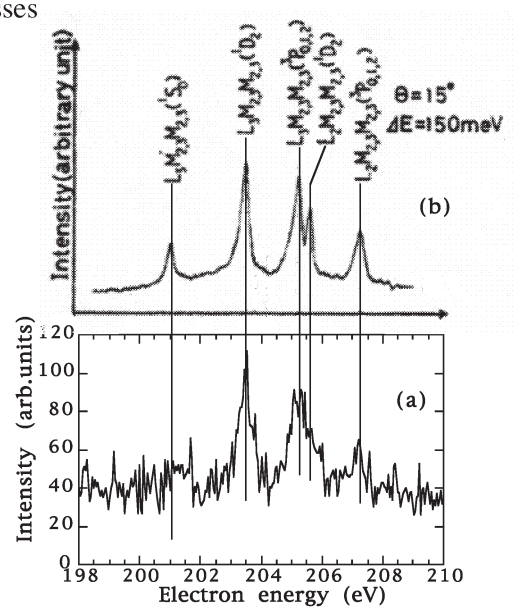

Fig. 1 Ar LMM Auger spectrum.

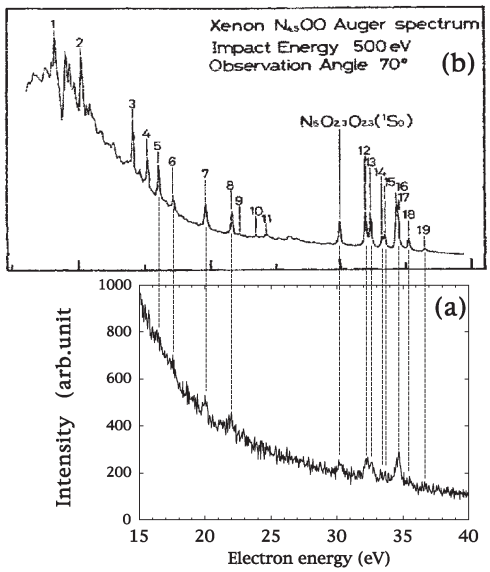

Fig. 2 Xe NOO Auger spectrum.

Reference

1)T. Kondow et al., J. Phys. B6 L156(1973)
2)B.S.Min et al., J.P.S.J.64 1183(1993)