CONVOY ELECTRON PRODUCTION IN COLLISIONS OF 460 MeV/u Fe IONS WITH CARBON FOILS – INITIAL CHARGE STATE DEPENDENCE

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The energy and angular distributions of electrons emitted in ion-solid collisions have been investigated. The spectra of electrons emitted with the same velocities as the incident ions are known to have a cusp-shaped peak. These electrons are called convoy electrons.

We have already reported on the spectra of convoy electrons produced in 390 MeV/u Ar^{17+} ion collisions with carbon foils with thicknesses from 25 to 8700 $\mu g/cm^2$ [1]. The beam was provided at Heavy Ion Medical Accelerator in Chiba (HIMAC). The electron spectra were measured with a magnetic analyzer. We measured the target thickness dependence of the spectra shape. The width of the convoy electron peak was found to decrease as the foil thickness increased from 25 to about 500 $\mu g/cm^2$. This phenomenon reflects the evolution of the projectile excited states and the initial states from which the electrons are emitted.

In the present experiment, we have measured the spectra of convoy electrons produced in collisions of 460 MeV/u $Fe^{23+,24+,25+}$ ions with carbon foils with thicknesses from 50 to 1900 $\mu g/cm^2$ in order to investigate the initial state dependence of the peak shape of convoy electrons. Figure 1 shows the energy spectra for 50 $\mu g/cm^2$ carbon foil. The peak width for Fe^{25+} ions is similar to that for Fe^{24+} ions, but broader than for Fe^{23+} ions, reflecting the initial states of the emitted electrons.

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The electrons of the incident Fe^{24+} and Fe^{25+} ions occupy the 1s states. On the other hand, the incident Fe^{23+} ions have the electrons in the 2s states. For thin targets, most of the convoy electrons are emitted from the 1s and 2s states for $Fe^{24+,25+}$ ions and Fe^{23+} ions, respectively. The cusp shape for Electron Loss to the Continuum (ELC) process in ion-atom collisions was calculated using a Born approximation [2]. It is shown that the width of the cusp peak of the electrons emitted from 2s is narrower than for 1s. The observed result is in agreement with this calculation.

The convoy electron spectra have been calculated with the simulation based on the classical transport theory (CTT) [3]. In this theory, the electron trajectories are calculated classically taking account of the projectile Coulomb potential and the elastic and inelastic collisions inside solids. The good agreement is obtained between this simulation and experiment [4].

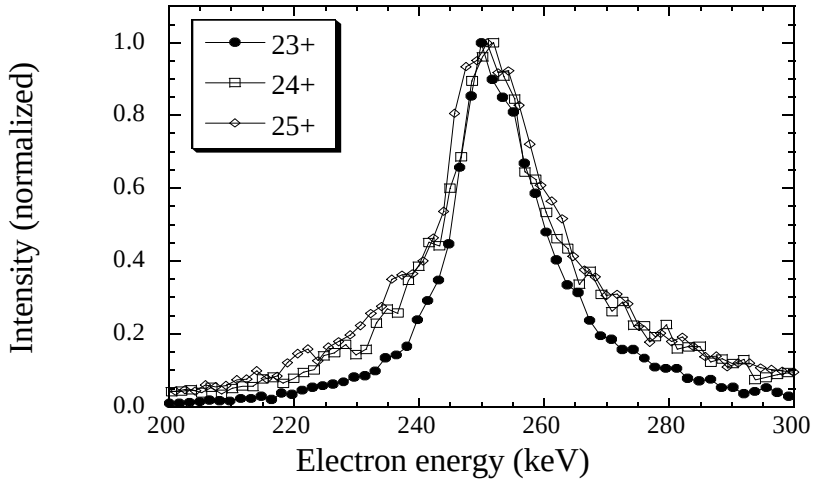

Fig. 1. Energy spectra of electrons ejected at 0º in collisions of 460 MeV/u $Fe^{23+,24+,25+}$ ions with 50 μg/cm^2 carbon foil.

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