§40. Measurements of Absolute Cross Sections for Electron Capture Processes of Low Energy Multiply Charged Heavy Metal Ions in Diverter Region

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Electron capture process of highly charged ions is a dominant process in fusion plasmas and process plasmas. Absolute cross sections of that are useful information for controlling and measuring the plasmas. However, there are few data with absolute value for electron capture of highly charged ions. Especially, the absolute cross sections are lack in low collision energies. The cross sections in low energy range below 10 eV are very useful for plasmas in diverter region. In the present work, the absolute cross sections for electron capture processes of tungsten ions are measured in the low energy region below 100 eV/u.

The experimental apparatus and measuring procedure have been previously described in detail [1]. The main features are only summarized here. Figure 1 shows a schematic diagram of the apparatus used. The apparatus was composed of a tandem mass spectrometer with two electronic magnets of MS1, MS2 and compact EBIS type highly charged ion source named mini-EBIS. An ion beam guide named OPIG with a collision cell is a key technique for low energy collision experiments. The OPIG consists of eight parallel Mo poles. Supplying a high frequency electronic field to OPIG enable us to measure the cross section down to 0.1 eV/u collision energy. Projectile tungsten ions were produced in mini-EBIS using $W(CO)_6$. Stable producing of W^{7+} is succeeded in the present work Tungsten ions of W^{7+} were extracted from mini-EBIS and mass selected with MS1. Projectile ions were injected to the collision cell with OPIG. In the collision cell, the charge changing ions of W^{6+} and W^{5+} were produced as followed reactions;

$W^{7+} + He \rightarrow W^{6+} + He^{+}$ single electron capture σ_{76},

$\rightarrow W^{5+} + He^{2+}$ double electron capture σ_{75}.

Projectile and product ions were extracted and mass selected with MS2 and detected with a channeltron multiplier. The absolute cross sections were measured using initial growth rate method. Gas pressures in the collision cell were measured with MKS baratron pressure gauge of type 690A. Collision energy was determined from a voltage difference between ion source and center of collision cell.

The measured absolute cross sections for single electron transfer process in collisions of W^{7+} with He are presented in Figure 2. We could not obtain absolute cross sections for double electron transfer process due to their small values below 5×10^{-18} cm^2. The overall uncertainty in the measured cross sections was estimated to be approximately $\pm$20%. The cross sections for W^{7+} -He collision system obtained here are one order smaller than that for multiply charged ions with same charge state. Ions with high Z number like tungsten may have a large diameter of electron clouds, then an interaction area of that is probably large. The small value of cross sections obtained here is not consistent with that expectation. We have continued to measure the cross sections to obtain the concrete values.

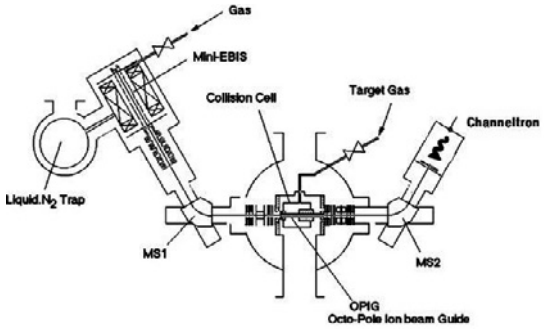

Figure 1. Schematic diagram of the experimental set up.

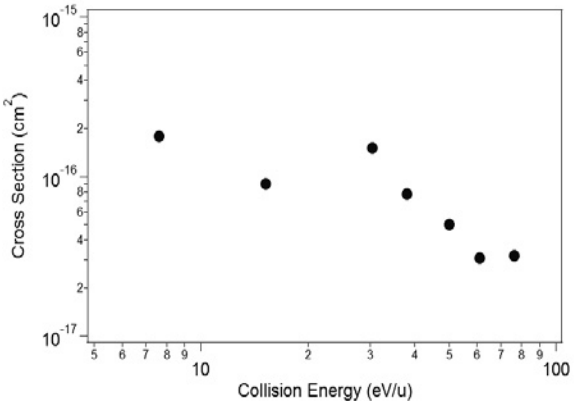

Figure 2. Absolute cross sections σ_{76} for single electron capture process of W^{7+}-He .

[1] Okuno K, Soejima K and Kaneko Y 1991 *Nucl. Instrum. Methods* B **53** 387