§18. Development of a Multiply Charged Lithium Ion Source for an Ion Collision Experiment

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Lithium atoms and ions are sometimes used for the purpose of plasma diagnostics in fusion devices. Therefore, cross section data and any knowledge of collision dynamics for these particles are known to be important and useful in controlled thermonuclear fusion research. In order to establish the plasma modeling in the low-temperature boundary and edge plasmas which took in the behavior of lithium ion more accurately, cross section data of the charge transfer for Li^{q+} (q = 1, 2, 3) ions in collisions with various atoms or molecules are essential.

However charge transfer cross section measurements of lithium ions are still sparse, particularly at low collision energies. As an example, charge transfer cross sections of Li^{3+} ions in collisions with He atoms are shown in Fig. 1. To the best of our knowledge, experimental cross section data were reported by Shah and Gilbody[1)], Wirkner-Bott *et al.*[2)], and Allison *et al.*[3)] at energies below 1 MeV. At the collision energies below 10 keV, Errea *et al.*[4)] only treated theoretically the single charge transfer process in this collision partner. One of the reasons why these data are scarce is thought to originate in the difficulty of generating of slow multiply charged lithium ions.

In this study, therefore, an ion source which can extract the doubly and triply charged Li ions will be developed to measure the charge transfer cross sections of multiply charged Li ions colliding with many species of atoms and simple molecules. As a first step of the present project, a new type ion source which a surface ionization and an electron impact were combined was constructed. Figure 2 shows the cross sectional view of the present multiply charged Li ion source.

The singly charged lithium ions were produced with a surface ionization method. A platinum foil spot-welded to a tungsten filament was used as an anode for a lithium ion emitter, which was coated with a mixed powder of Li_2CO_3, Al_2O_3, and SiO_2. The Li^+ ion beam was accelerated extracted up to 0.1 keV by the electric field and decelerated to approximately 0.01eV. This beam collided with an electron beam generated with a BaO cathode. In consideration of the electron energy which gives the maximum value of the double ionization cross section of Li^+ ions to generate the Li^{3+} ions, the energy of the electron beam enabled it to vary up to 0.5 keV. The produced Li^{2+} and Li^{3+} ions were extracted, focused, and accelerated with several electrodes, and then introduced into a mass/charge spectrometer.

The power supply for a control of a Li^+ ion generation part was newly constructed using some commercially available stabilized DC power supply units. The whole setup of an ion source and a vacuum system is in progress now, and performance test of the present ion source for generating the multiply charged lithium ions will be performed soon.

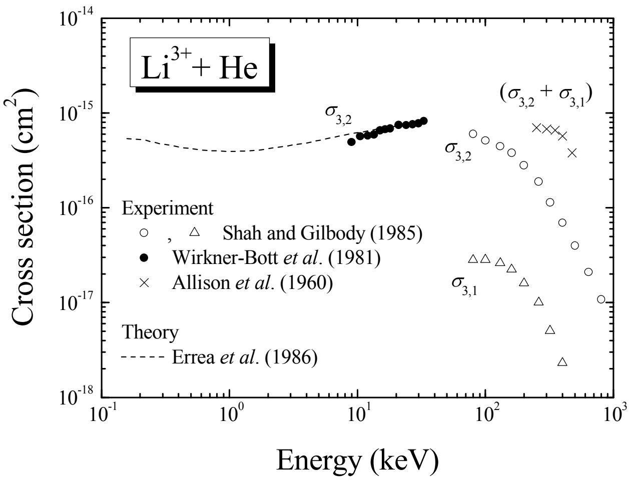

Fig. 1. Charge transfer cross sections of Li^{3+} ions colliding with He atoms.

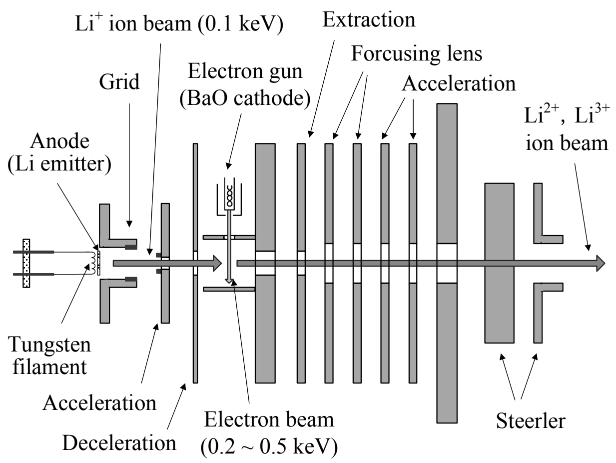

Fig. 2. Cross sectional view of the present multiply charged Li ion source.

1) Shah, M.B. and Gilbody, H.B.: J. Phys. B **18** (1985) 899.
2) Wirkner-Bott, I. *et al.*: J. Phys. B **14** (1981) 3987.
3) Allison, S.K. *et al.*: Phys. Rev. **120** (1960) 1266.
4) Errea, L.F. *et al.*: J. Chem. Phys. **84** (1986) 5422.