

§17. Charge Transfer Cross Sections for Multiply Charged Slow Carbon Ions in Collisions with Various Hydrocarbon Molecules

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In the edge plasmas of recent large tokamak devices with low-Z plasma facing components such as carbon materials, there are many kinds of low charge state ions and carbon containing molecules. Among many collision processes relevant to low temperature fusion edge plasmas, charge transfer of these ions with molecules play an important role in determining properties of high temperature plasmas at the core region. We therefore systematically measured the charge transfer cross sections of H^+ , He^+ , C^+ and O^+ ions in collisions with various molecules.¹⁾

In this work, as a continuing study, we have measured the charge transfer cross sections of the C^{q+} ($q = 2, 3$) ions in collisions with CH_4 molecules in the energy range between 0.35 and 3.34 keV/ q . The C^{q+} ($q = 2, 3$) ions were extracted from the compact electron beam ion source called micro-EBIS.²⁾ This EBIS is constructed using a strong ring permanent magnet of Fe-Nd-B. The multiply charged carbon ions were produced in a 3 cm long drift tube from high purity CO gas by impacting about 1 mA electron beam emitted from a barium oxide (BaO) cathode of 2 mm in diameter. Energy of an electron beam was set to about 2 keV. In order to maintain the constant electric potential for accelerating the electron beam, two high voltage supplies were separately applied to the cathode and the drift tube. Because $^{12}C^{3+}$ ions cannot be distinguished from $^{16}O^{4+}$ ions, enriched ^{13}CO gas was used for generating $^{13}C^{3+}$ ions. The cross sections of charge transfer were determined by the initial growth rate method with a position-sensitive micro-channel plate detector.

Figure 1 shows the cross sections for single- and double-charge transfer results in $C^{2+} + CH_4$ collision. The present single-charge transfer cross sections σ_{21} gradually increase with increasing collision energy, while the present double-charge transfer cross sections σ_{20} gradually decrease as the incident energy increases. Both the present cross sections are reasonably connected with the data of Itoh *et al.*³⁾

Figure 2 shows the cross sections for single-, double- and triple-charge transfer results in $C^{3+} + CH_4$ collision. The present single- and triple-charge transfer cross sections (σ_{32} and σ_{30}) gradually decrease with increasing collision energy, while the present double-charge transfer cross sections σ_{31} are almost constant. The present cross sections are reasonably connected with the data of Itoh *et al.*³⁾ The σ_{31} values are found to be larger than the σ_{32} values below 10 keV. At above 10 keV in

energy, this relation may be changed.

The measurements are now in progress for C^{q+} ($q = 2, 3$) ions in collisions with C_2H_2 , C_2H_6 , C_3H_8 and $n-C_4H_{10}$ hydrocarbons.

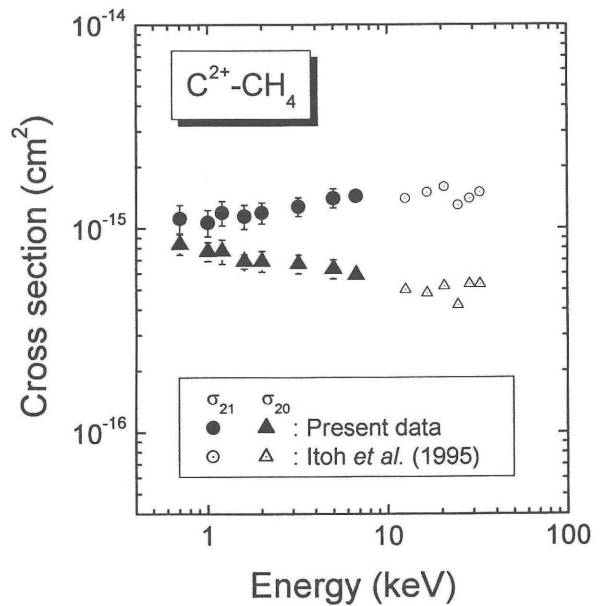


Fig. 1. Single- and double-charge transfer cross sections for C^{2+} ions colliding with CH_4 molecules.

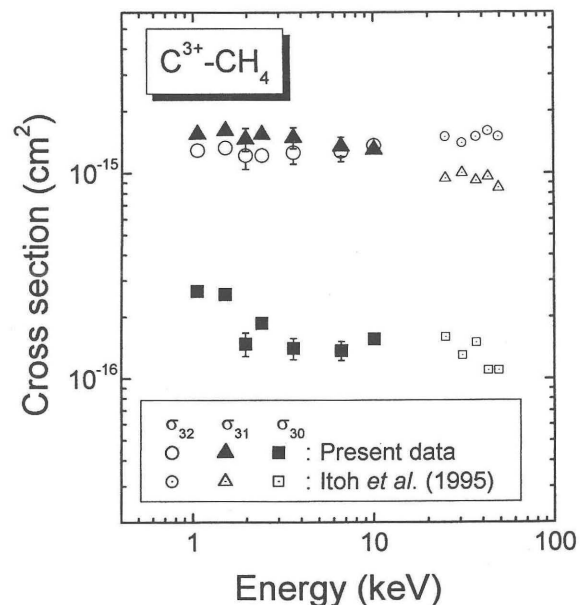


Fig. 2. Single-, double- and triple-charge transfer cross sections for C^{3+} ions colliding with CH_4 molecules.

Reference

- 1) Kusakabe, T. *et al.*: Phys. Rev. A **60** (1999) 344./ Kusakabe, T. *et al.*: Phys. Rev. A **62** (2000) 062714./ *ibid.*: 062715.
- 2) Kusakabe, T. *et al.*: Physica Scripta **T73** (1997) 378.
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