Charge transfer cross sections of slow light element ions in collisions with carbon tetrafluoride and sulfur hexafluoride molecules

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Synopsis Charge transfer cross sections of protons and helium ions in collisions with CF_4 and SF_6 molecules have been measured in the energy range from 0.20 to 4.0 keV based on a growth rate method. The present cross sections are almost increasing with the collision energy. In proton collisions, the process is endothermic. While the process in He^+ ion collisions is exothermic, and the dissociative charge transfer processes are expected.

Both carbon tetrafluoride (CF_4) and sulfur hexafluoride (SF_6) are kinds of greenhouse gas. Although releasing these molecules into an atmosphere is already restricted, such concentration in the atmosphere is increasing every year.

On the other hand, the plasma called a solar wind is released out of the sun, and is deeply concerned with the formation of an aurora in the earth's atmosphere. Although the main factor of formation of aurora is the electron, proton aurora is also sometimes observed. Besides, helium is 2nd most elements as a constituent of the heavy particle in the solar wind.

However charge transfer cross section measurement of light element ions in collisions with many kind of fluorocarbons and SF_6 is sparse. To establish the cross section data and obtain more comprehensive understanding of the charge transfer processes in ion-molecule collisions of the fluoride family, therefore we have measured, in the present study, the charge transfer cross sections of protons and helium ions colliding with CF_4 and SF_6 molecules in the energy range from 0.20 to 4.0 keV using a growth rate method.

The ion beam extracted from an electron impact ion source was mass-analyzed with a Wien filter and was introduced into a collision cell in which target gases of high purity were filled. The primary positive ions and product neutral atoms emerging from the cell after the collisions were charge-separated and detected with a position-sensitive micro-channel plate detector. Charge transfer cross sections were derived based on the growth rate method.

Threshold electron energy in the ion source for producing the metastable state He^+*(2s ^{2}S) ions from ground state He atoms is 38.2 eV. In order to determine the charge transfer cross sections of the ground state He^+(1s ^{2}S) ions, the effective electron energy into the ion source was set to 30.3 eV.

Figure 1 shows the present preliminary results for charge transfer cross sections of protons colliding with CF_4 and SF_6 molecules. The ionization potential of both molecules is the same, and these collision processes are endoergic reactions. So that the present preliminary cross section data increase toward higher energies. The previous data of Martinez *et al*. [1] for p + SF_6 collisions are 30 % smaller than the present results.

The present data of CF_4 are found to be smaller than the present data of SF_6. As for this, the difference in the polarizability of a target molecule may be concerned.

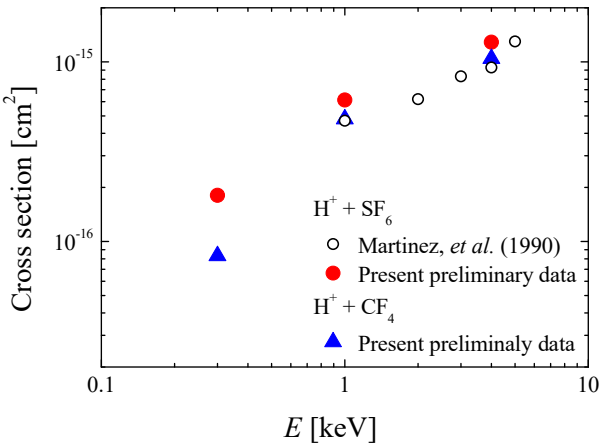

Figure 1. Charge transfer cross sections of protons colliding with CF_4 and SF_6 molecules.

Since the present process in a helium ion collision system are exoergic reactions with large energy defect, the dissociation processes of a target molecule are expected. Final data analysis is under progress.

References

[1] H. Martinez *et al.* 1990 *Phys. Lett. A.* **146** 517

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