Multiple ionization and dissociation of ethylene induced by collision of Xe^{9+}

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Synopsis Multiple ionization and subsequent ion-ion dissociation of ethylene was studied by using intermediate energy of Xe^{9+}. Delayed dissociation of $C_2H_4^{2+} \rightarrow C_2H_3^+ + H^+$ is discussed.

Collision-induced multiple ionization of organic molecules sometimes leads to characteristic reactions such as hydrogen migration and efficient formation of H_3^+ [1,2]. As for ethylene, which is the smallest planar hydrocarbon, multiple ionization by collision of Ar^{8+} at low-energy region, where electron-capture is dominant, was studied focusing attention onto the fragmentation scheme [3]. In the present study, collisional multiple ionization of ethylene was studied at considerably higher energy region, where electron emission from the target also works.

Experiments were conducted at the beamline in the Low Energy Ion Beam Facility of the Inter-University Accelerator Centre, using 2.25 MeV Xe^{9+} beam [4]. A schematic drawing of the setup is shown in Fig. 1. The target ethylene was introduced as an effusive beam, and the emitted electrons triggered the multi-hit position sensitive TOF measurement of the recoil ions.

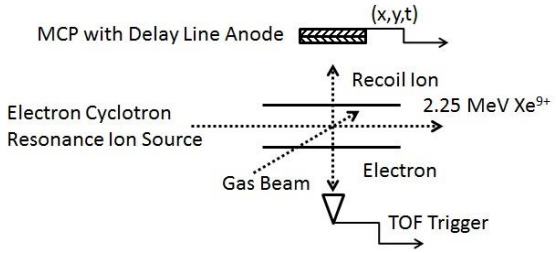

Figure 1. Schematic view of the apparatus. The details are given in [4].

A double-hit time-of-flight coincidence map, around the area for the heavy fragment ions, m/q = 24 – 28, with the light ones, m/q = 1 – 3, is shown in Fig. 2, in which the channels are represented as $[C_2H_3^+,H^+]$ for example. The $[C_2H^+,H_3^+]$ island is very weak but clearly above the background level. The diagonal line starting from the island $[C_2H_3^+,H^+]$ indicates delayed dissociation takes place. While the decay profile slightly deviates from a single exponential function, the lifetime of the metastable $C_2H_4^{2+}$ is estimated to be an order of 100 ns. For other channels, delayed reactions were not observed. By further analysis of the velocity vectors of the fragment ion pairs, the kinetic energy release distribution and angular distribution with respect to the projectile beam direction will be discussed.

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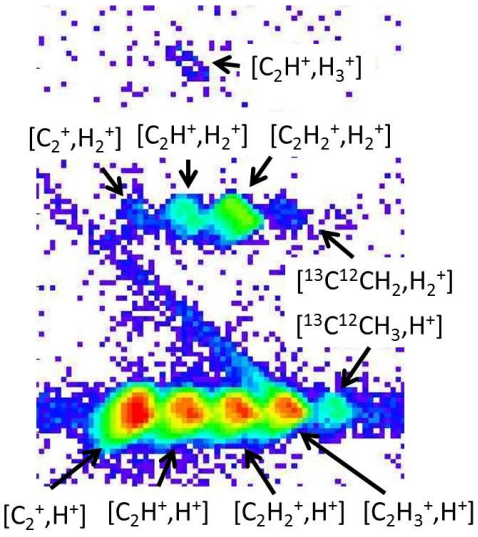

Figure 2. TOF coincidence map for $[C_2H_{4-n}^+(n=1\sim4), H^+]$, $[C_2H_{4-n}^+(n=2\sim4), H_2^+]$, and $[C_2H^+, H_3^+]$ channels. The color indicates the intensity in the log scale. The diagonal line is due to the delayed dissociation.

References

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