Journal of Physics: Conference Series

Excitation energy distributions and statistical dissociation of C_{70}^{2+} prepared in collisions with F^+ ions at 3 keV

Excitation energy distributions and statistical dissociation of C_{70}^{2+} prepared in collisions with F^+ ions at 3 keV

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Synopsis The statistical dissociation of C_{70}^{2+} has been studied as a function of the internal energy using collision induced dissociation under energy control (CIDEC). Doubly charged ions C_{70}^{2+} were prepared in F^+ (3 keV) + $C_{70} \rightarrow F^- + C_{70}^{2+}$ collisions. Up to seven successive evaporation of C_2 have been observed in a time range of 1.7 µs. The dissociation energies of C_{70-2m}^{2+} (m=1-7) were determined using a statistical cascade model to reproduce the excitation energy distribution of C_{70}^{2+} parent ions for each dissociation channel. Results are in good agreement with previous theoretical calculations.

The fragmentation pattern of C_{70}^{2+} is studied with well-controlled internal excitation energy in $F^+ + C_{70} \rightarrow F^- + C_{70}^{2+}$ collisions using the CIDEC method [1]. By analyzing the kinetic energy loss of the scattered negative ions F^-, the internal energy distribution of the doubly charged C_{70} parent ions has been obtained for the main dissociation channels, i.e., the successive evaporation of C_2 units.

As expected, the dissociation of C_{70}^{2+} presents a statistical behavior. Indeed, for the first C_2 emission the average excitation energy of the C_{70}^{2+} parent ion is about 53 eV which is much larger than the dissociation energy (9.5 eV). For the second and third evaporations, an extra amount of energy of about 8 and 16 eV is required, respectively. In the time range of the experiment (1.7 µs) up to seven C_2 evaporation have been observed leading to C_{56}^{2+} daughter ion (figure 1). The corresponding internal energy of the C_{70}^{2+} parent ion is about 100 eV. It is noteworthy that the C_{60}^{2+} daughter ion appears at excitation energy of about 81 eV. An extra 8.5 eV leads to the formation of C_{58}^{2+} fragment. From previous experiment [1] the internal energy of the C_{60}^{2+} parent ions was measured to be about 45 eV for the emission of the first C_2 unit. This tends to indicate that C_{60}^{2+} ions formed from C_{70}^{2+} parent ion may have a rather high excitation energy.

Using the Arrhenius law to calculate the dissociation rates, the internal energy distributions were reproduced with a cascade statistical model without any assumption on the excitation energy. The obtained dissociation energy of C_{70-2m}^{2+} (m=1-7), treated as free parameters in the model, are found in good agreement with previous calculations [2].

The ionization process of C_{70}^{2+} in competition with the C_2 evaporation channel will also be discussed.

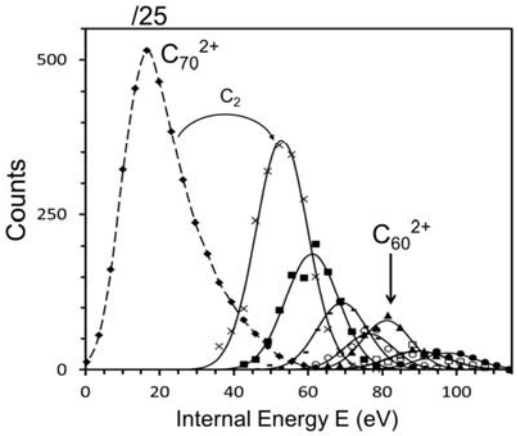

Figure 1. Symbols: experimental internal energy distributions of C_{70}^{2+} parent ions for successive C_2 evaporations. The amplitude of the C_{70}^{2+} peak has been divided by a factor 25 and the dash line is to guide the eyes. Plain lines: Gaussian fits of the energy distributions of C_{70}^{2+} parent ions leading to C_{70-2m}^{2+} (m=1-7) daughter ions.

References

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