LASER ABLATION OF GRAPHITE: FUNDAMENTALS AND APPLICATIONS

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Mass spectroscopic studies on the laser ablation of graphite have been performed in nonreactive and reactive atmospheres to investigate the formation mechanisms of small carbon cluster ions and their reactivities.

Formation mechanisms of C_1^+, C_2^+, and C_3^+ ions by laser ablation of graphite are investigated using a time-of-flight(TOF) quadrupole mass spectroscopy. The laser ablation is performed in conjunction with a pulsed Ar expansion to elucidate the third body effect on the formation of the small carbon cluster ions. Drastic enhancement of C_2^+ ion signal is observed by increase of the local pressure near the target as shown in Fig.1, indicating that C_2^+ ions are efficiently formed by recombination of carbon atoms and subsequent ionization. The branching ratio of C_1^+, C_2^+, and C_3^+ ions and their mean translational energies are different from those of neutrals. Also, the TOF spectra for C_n^+ ions show multiple peak structures, which implies that different mechanisms are involved in the formation of C_n^+ ions.

A reactive laser ablation of graphite in a pulsed oxygen jet have been performed. Significant changes in the relative enrichment of carbon ions including anomalous enrichment of C_2^+ ions as well as formation of CO^+, C_2O^+, and C_3O^+ ions are observed as shown in Fig. 2. Collision-induced dissociation and reactive scattering of carbon ions prevail by injection of the oxygen jet to the carbon plume. The TOF spectra of each carbon ion consist of a fast and a slow component, which are considered to represent different formation mechanisms. By analyzing the changes of TOF spectra as a function of the delay time between the laser pulse and oxygen jet, we examine the effects of collisions on the formation of carbon ions.

Laser ablation of graphite in a nitrogen atmosphere has also been attempted with an ultimate goal to deposit carbon nitride films. The formation mechanisms of CN molecules in the gas phase and their transport to a substrate are investigated by optical emission studies. The effects of background gas pressure, laser fluence, and RF plasma on the characteristics of carbon nitride films are studied by SEM, XPS, Raman, and FT-IR.

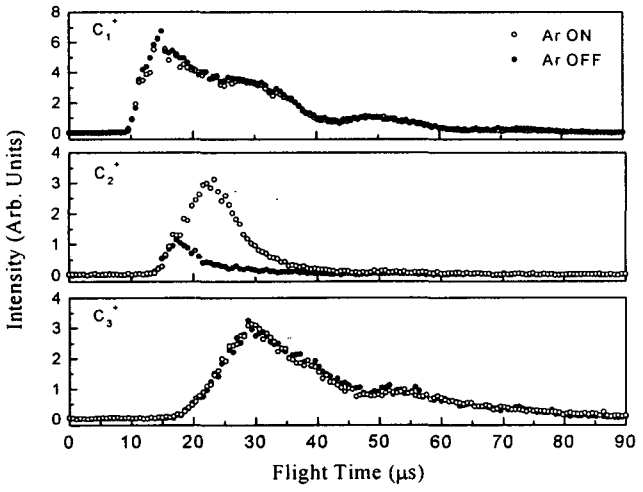

Figure 1. TOF spectra of carbon ions produced by laser ablation of graphite with Ar pulse on and off.

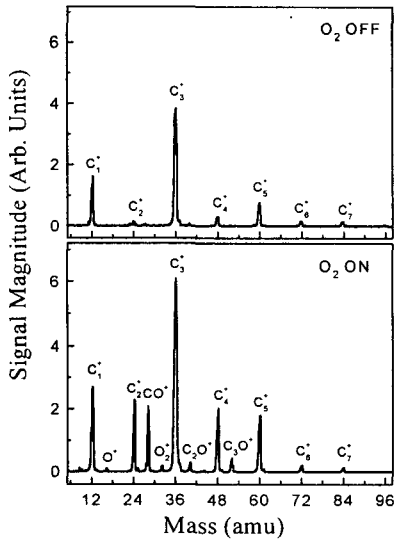

Figure 2. Mass spectra of ions produced by laser ablation of graphite with O_2 pulse on and off.