Growth Dynamics of Fullerenes and Related Materials

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The followings are general features observed in the mass production of fullerenes and related materials. 1) High temperature condition (more than 500 C) is necessary to obtain high yields of fullerenes as well as carbon nanotubes. This condition has generally been realized by use of an electrical furnace or an arc heating. 2) Production of high density of carbon vapor is required by means of pulse laser vaporization or arc discharge under the relatively high pressure condition. Rare gases have widely been used. 3) Long time annealing (at least more than a second) in a furnace is very effective in order to obtain the higher yield and grade carbon nanotubes. These observations for high yields of fullerenes and carbon nanotubes seem to lead to the solution for the still unknown growth processes of fullerene and related materials. Thus in the present work, we will demonstrate in-situ observations of carbon network formation processes, placing special interest in the time evolution of growth processes. For this purpose, we used several different optical spectroscopic measurements combined with a conventional production analysis method.

Black body radiation measurements were found to be very useful to identify the time, spatial and temperature evolutions of carbon vapor after laser irradiation. Particularly, the temperature evolution of carbon vapor under the high furnace temperature conditions was found to be very special at least within an msec time scale, suggesting the trace of an exothermic chemical reaction followed by the fullerene-like network formation. Furthermore, the detection of C2 chemical species was also examined by means of a laser induced fluorescence method. It should be quite interested to note that the time and spatial history of C2 formation is quite resemble to those observed by the black body measurements.