§11. Study on Development Processes of Carbon Dusts in a Fusion Devices

Kenmotsu, T., Wada, M., Hasegawa, Y. (Doshisha Univ.),
Nakamura, H., Takayama, A., Ito, M.A., Ashikawa, N.,
Nishiura, M. (Univ. Tokyo),
Hasegawa, Y., Murata, M. (Saitama Univ.),
Saito, S. (Kushiro Nati. Coll. of Tec.)

Dusts in plasmas attract extensive attention from the viewpoint of estimating the inventory of tritium atoms in a nuclear fusion device. The dusts are expected to absorb a considerable amount of tritium atoms and distribute throughout a fusion device. Carbon made first walls of a fusion device emit carbon clusters and hydrocarbons, which diffuse into plasma and agglomerate to form dusts in low temperature edge plasma regions. The origin of dusts in fusion experiment devices should be carbon walls. Carbon should be released in the forms of atoms, clusters and particles from the walls most probably by sputtering [1]. Study on dust formation in plasma has been already started. Sizes and cross-sections of carbon dusts have been characterized by a scanning (SEM), transmission (TEM) electron microscopes, and focused ion beam (FIB) system [2].

A small experimental setup has been designed and is being built to form carbon dusts and clarify the formation processes. The designed experimental system confines plasma inside of a graphite container. The micron sized carbon dusts have been observed in the small experimental setup after hydrogen plasma discharge by means of a scanning electron microscope (SEM). Shown in Fig.1 is the designed experimental system confines hydrogen glow plasma inside of a graphite container installed in a vacuum chamber made of glass which is 70 mm diameter and 370mm long. A carbon hollow cathode is installed inside of the all graphite wall container that serves as the anode of the discharge. The amounts of the supplies of hydrogen gas to the vacuum chamber can be controlled by the angle valve. The optical paths are opened in the bottom of the discharge container so as to observe plasma around the carbon rod using the WEB camera.

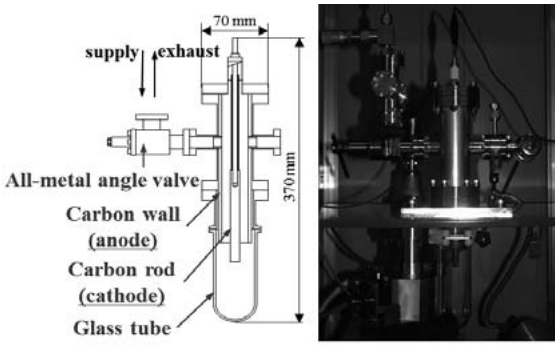

Fig.1 Schematic diagram of experimental setup

Hydrogen gas had been sealed by the angle valve after hydrogen gas pressure reaches the saturation level around 100 Pa. Thus, hydrogen gas is not supplied to the vacuum chamber during the experiments. The glass slides has been positioned on the lower part of the carbon rod, so as to despite carbon dusts on the slide.

Figure 2 (a) and (b) show SEM images of carbon dusts formed on the slides in the designed experimental system after hydrogen plasma discharge. Micron sized carbon dusts have been observed, and the observed carbon dusts indicate both structures like sphere. Surface and inner structures of carbon dusts have been shown in Fig.2 (a), (b), respectively. We have observed the carbon dusts are cracked spontaneously due to exposing the air after experiments. A structure of carbon dusts indicates the formation processes up to develop micron sized carbon dusts. The carbon dusts which have spherical structure are believed to develop under gaseous phase.

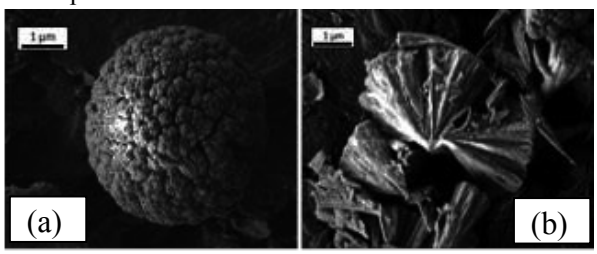

Fig. 2 Surface (a) and inner (b) structures of carbon dusts after hydrogen plasma discharge.

Figure (3) shows particle distributions of size on carbon dusts with discharge durations of 3.0, 4.5, 6.0, 7.5 and 9.0 hours. The experimental results have indicated that the numbers of carbon dusts decrease linearly with increasing the size of carbon dusts and the number of dusts of larger size increase for longer duration time of plasma discharge.

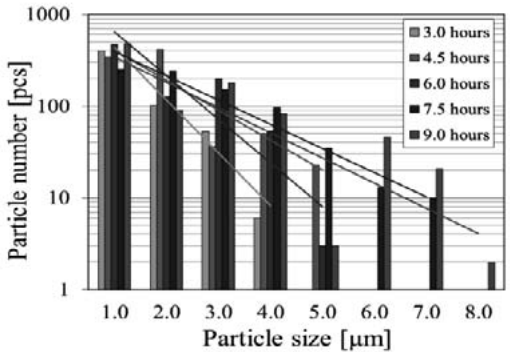

Fig. 3 Distributions of size on carbon dusts with discharge durations of 3.0, 4.5, 6.0, 7.5 and 9.0 hours.

1) C. Arnas, A. Mouberi, K. Hassouni, A. Michau, G. Lombardi, X. Bonnin, F. Benedic, B. Pegourie, J. Nucl. Mater. **390-391** (2009) 140.
2) N. Ohno, M. Yoshimi, M. Tokitani, S. Takamura, K. Tokunaga, N. Yoshida, J. Nucl. Mater. **390-391** (2009) 61.