§13. Research on Formation of Dust in Fusion Device Using Infrared Spectroscopy

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Dusts are found formed in fusion experiment devices like LHD, and identification of their formation mechanism is one of the hottest topics in nuclear fusion research. Sizes and cross-sections of carbon dusts have been characterized by a scanning (SEM) and transmission (TEM) electron microscopes[1]. The SEM images indicate the productions of carbon dusts with an agglomeration of sub-micron size particles. Measured sizes of dusts are distributed for a wide range. Carbon dusts are considered to be generated from carbon re-deposition layers formed on a surface of a plasma-facing component. The time development of the agglomerations of carbon in a fusion device is one of most important information for fusion device development. However, the fundamental processes related to dust formation in the edge plasma environment have not been understood yet. Thus, a small experimental setup shown in Fig.1 has been designed to investigate the time development of carbon dust, and to quantify the validity of infrared absorption spectroscopy through investigating the dust formation in a fusion device. The experimental chamber is made of a 10 cm diameter, 10 cm long cylindrical glass tube.

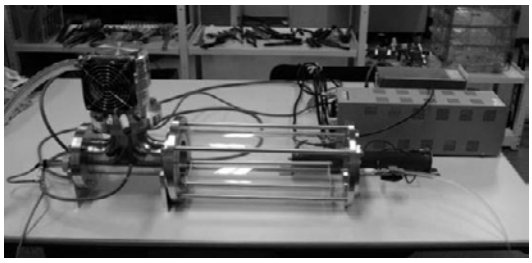

Fig. 1. Experimental setup.

A carbon wall shown in Fig.2 is inserted into the cylindrical glass chamber, and carbon dusts are created due to plasma discharges. Argon discharges shown in Fig.3 have been done using the small experiment setup.

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Fig. 2. Carbon wall

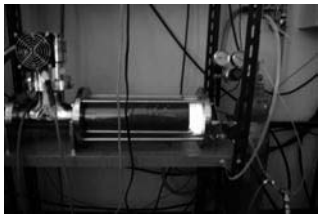
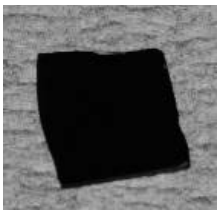


Fig.3. Ar discharge

The transparent prepared have been placed in the inside of cylindrical tube chamber before the discharge operation. After argon discharges, the surface of the prepared becomes black as shown in Fig.4. Figure 5 shows the SEM images of the prepared after argon discharges. Carbon dusts have been observed by scanning electron microscope. Size of these carbon dusts are of the order of μm. The carbon dusts are expected to create by agglomerating sputtered carbon atoms from carbon wall due to argon discharge.



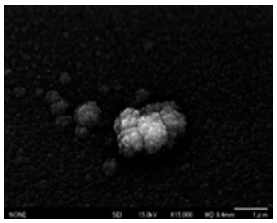


Fig. 4. Prepared after Ar discharge Fig.5. Carbon dust

We have confirmed that the present experimental setup can create the carbon dusts, but the time development of carbon dusts does not estimate using the present experimental system. Thus, in order to observe the time development of carbon dust, we plat to use the infrared adsorption spectroscopy of hydro carbon molecules. An experimental device is being fabricated so as to measure the infrared absorption spectra of hydrogen discharges with very dilute contents of hydrocarbon based on the preset experimental setup. The designed experimental system shown in Fig.6 confines hydrogen plasma inside of a graphite container. The discharge region is 80 mm diameter and 300 mm long. A carbon hollow cathode is installed inside of the all graphite wall container that serves as the anode of the discharge. An optical path is opened on both sides of the discharge container, so that infrared absorption spectra can be measured. The species composition of the gas effusing out of the graphite container is monitored by a quadrupole mass analyzer. We plan to observe the infrared adsorption spectra of hydro carbon molecules using the designed experimental setup nearly future.

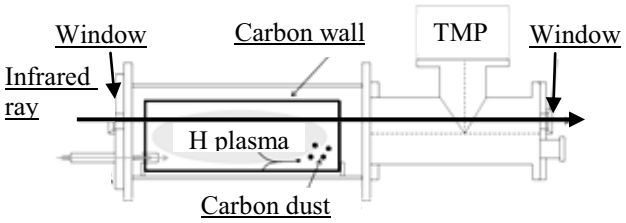


Fig.6. Schematic diagram of the small dust agglomeration experiment system.

1) N. Ohno, M. Yoshimi, M. Tokitani, S. Takamura, K. Tokunaga, N. Yoshida :J. Nucl. Mater. **390-391** (2009) 61.