§27. Dust Collection with a Compact Drift Tube in a Divertor Simulator

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In fusion devices, dust particles are generated due to plasma-wall interactions. They have been pointed out to pose potential problems for long-term operation. One of the strategies to reduce the dust amount in fusion devices is removal of dust particles from bulk plasma and chamber wall. Therefore, dust transport is an important research topic to realize reduction of dust amount in fusion devices.

So far, we have found that the flux of dust particles increases with bias voltage of dust collection substrates in the Large Helical Device (LHD) and in the divertor simulator in our laboratory[1), 2)]. Based on the results, we are developing a compact drift tube to obtain information on dust transport in electrostatic field.

For the compact drift tube, two parallel stainless-steel plates set with the gap of 5 mm between two plates. One plate is DC-biased and the other is grounded. Charged particles in the tube are attracted to one of the plates. From the size and collected position of the dust particles, we can obtain information of the dust transport.

Experiments were conducted in the divertor simulator. Dust particles were generated due to interactions between pulsed H_2 plasmas of 1100 W and graphite target (IG-430U). The total discharging period was 18000 sec. The top of the compact drift tube was set under the target at r = 80 mm from center axis of the plasma. Low-resistivity Si substrates were set on the inner side of both plates. The bias voltage of each experiments were +10 V and +30 V, respectively. We measured the size and shape of the dust particles on the substrates using scanning electron microscopy (SEM).

Collected dust particles can be classified into three kinds: comet shape (Fig. 1), spherical and flakes. So far we had observed the spherical particles and the flakes in previous dust collection experiments without the compact drift tube, but we observed comet shape dust particles for the first time using the tube. Energy dispersive X-ray (EDX) analysis shows the major compositions of these dust particles are carbon. Since the melting point of graphite is quite high, around 4000 K, comet shape dust particles might be polymer of C_xH_y or a-C:H with low melting point.

Figure 2 shows typical size distribution of dust flux collected on +10 V biased plate as a parameter of r. The total volume flux of comet shape particles monotonically decreases with increasing r. The peak size shows smaller for higher r as well as the size distribution become narrower. For the comet shape, the dust flux on +10V biased plate is larger than on grounded plate for each position r. The results indicate many dust particles are negatively charged. The dust flux of the experiment for +30 V biased has the same tendency as that for +10 V.

We measured the width, length, and incident angle of the comet shape dust particles. The ratio of length to width is in a range from 2 to 3 for both experiments. The dust incident angle with respect to the gravity direction increases from 0 to 40 deg. with increasing their width for the experiment for +10 V. For the experiment for +30 V, the data dispersion of the incident angle is wider than that for +10 V.

These results suggest that the comet shape dust particles contain information of collision of dust particles against the wall of the compact drift tube.

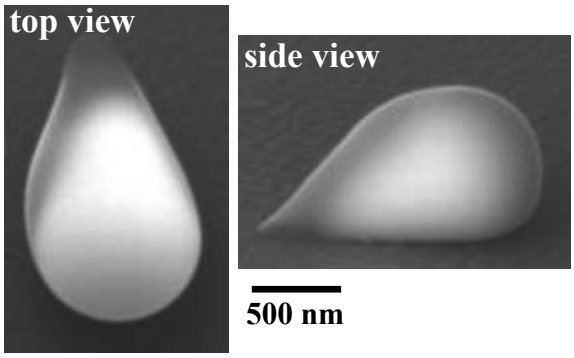

Fig. 1. SEM images of comet shape dust particle.

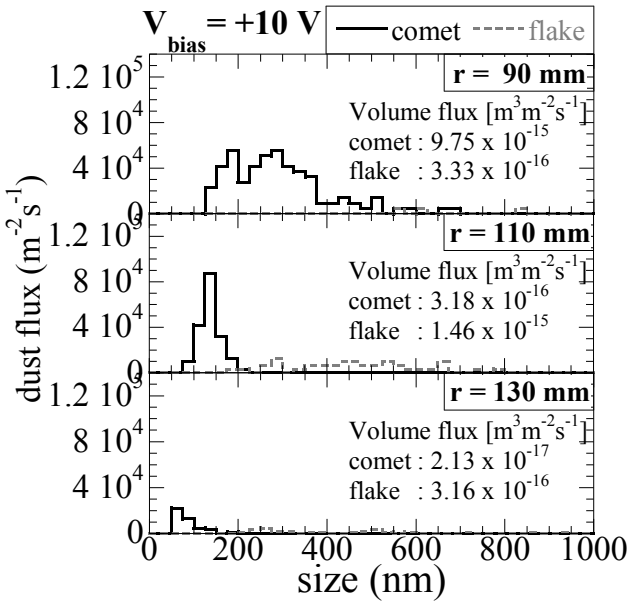

Fig. 2. Typical size distribution of dust flux on +10 V biased plate.

1) Koga, K., Nishiyama, K., Morita, Y., Uchida, G., Yamashita, D., Kamataki, K., Seo, H., Itagaki, N., Shiratani, M., Ashikawa, N., Masuzaki, S., Nishimura, K., Sagara, A., and the LHD Experimental Group: J. Nucl. Mater. **438** (2013) 727.

2) Koga, K., Tateishi, M., Nishiyama, K., Uchida, G., Kamataki, K., Yamashita, D., Seo, H., Itagaki, N., Shiratani, M., Ashikawa, N., Masuzaki, S., Nishimura, K., Sagara, A., and the LHD Experimental Group: Jpn. J. Appl. Phys. **52** (2013) 11NA08.