§32. Ejection of Pre-characterized Carbon Dust in LHD

Ashikawa, N., Masuzaki, S., Sagara, A., Tomita, Y., Muroga, T.

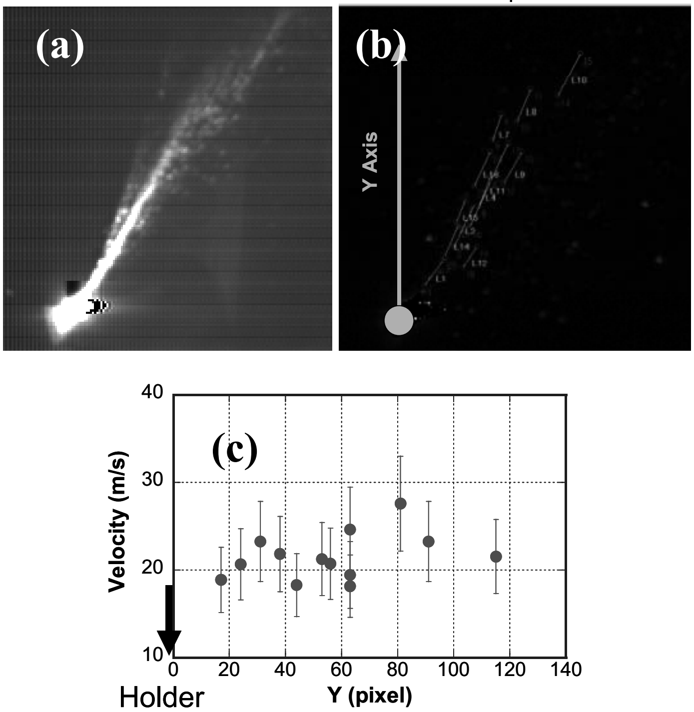
Dust ejection experiments are considered as a demonstration of moving dust particles reduced by chemical reactions and erosions from divertor targets. It is also an effective method to investigate a lifetime of dust particles. An initial position, a material composition and a diameter of dust particles are kwon and these dust particles interact with similar histories of plasma conditions, such as electron temperatures, on the way of their moving process. Dust ejection experiment was started using DiMOS in DIII-D and this result shows a useful method to understand dust dynamics.

We have three kinds of spherical glassy carbon dust of 8, 60, 120 microns, and these are the commercial size made by Tokai Carbon Co., LTD. From a typical diameter of ‘natural’ carbon dust in LHD is under 1 micron, and then a diameter of 8 micron is chosen in this ejection experiment. These carbon dust particles are set on a dust holder made by stainless steal and an initial amount of carbon dust particles is about 2.15g measured by microbalance. Ejected dust particles are estimated about 0.04g by an estimation of eroded dust volume on a dust holder. This dust sample holder is installed on the head of the movable material probe, which locates at the lower port in LHD and a dust sample holder with dust particles is set the position of divertor leg plasma before the plasma discharge.

Figure 1 (a) shows image of dust movement measured by visible high-speed camera. This direction of motion is limited and strong localized illumination intensity is only observed for a period of 0.3 sec. Figure 1(b) shows a tracing of dust movement for each particle. Each line indicates a trace of a dust movement. Velocity is not dependent on the their distances from the holder and a time of illumination for each particle is less than 5ms.

Figure 1 (c) shows velocities of dust particles using particles in Fig.1 (b). In these figures, Y=0 locates at a dust holder position. A velocity is not dependent on there distances from a dust holder and starting points of illumination are not the same in Fig.1 (b). Only heated particles can be observed with strong illumination, and a starting point of illumination means to start some interaction, for example between dust particles and plasmas.

A different type of dust, a conglomerate of dust particles, is observed in the same experiment and a direction of this motion is almost straight line on this horizontal plane as shown in Fig. 2. An illumination area expands and this dust is having an ablation cloud. Until 0.9227s, a velocity is accelerated, but after 0.9227s, a velocity drops by ablation. A conglomerate of dust particles was considered to enter to the SOL plasma. And then, a direction of motion changes. Because from t=0.9227 to t=0.9262s, a center position of conglomerate dust is almost same and velocity changes. A direction of ablation could is the same direction of motion. An illumination time is 10-20 ms and it is longer than no accelerated dust particles. This ablation phenomenon relates a discussion about lifetimes of dust particles.



Figs.1 (a) Image of dust movement by high-speed camera and (b) Tracing image of movement with each dust particle. (c) velocity of dust particles using particles in Fig.1(b). Y=0 indicates a center of dust holder.

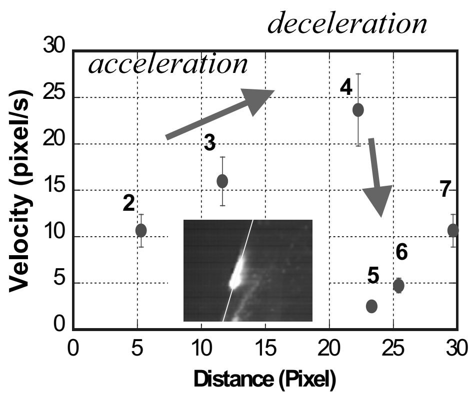


Fig.2 Velocity of conglomerate of dust particles with ablation cloud.