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グラファイトと重水素プラズマの相互作用で発生したダスト捕集
Sampling Dust Particles Generated due to Interaction Between a Graphite and Deuterium plasmas

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In fusion devices, dust particles pose potential problems in future long-term operations. The dust particles can contain a large amount of tritium, and their existence in the device could also lead to deterioration of the plasma confinement. Therefore, it is important to understand their formation mechanism and their transport in fusion devices having carbon divertors. Now, deuterium plasma operation is being planned in the Large Helical Device (LHD) in the immediate future, and hence preliminary experiments concerning dust formation using the helicon plasma reactor provide important information on the dust formation due to the deuterium plasma – carbon wall interaction in the LHD. In this paper, we report the results of the collection of dust particles having a size of μm – nm, which are formed due to the interaction between graphite and helicon deuterium plasmas in the helicon plasma reactor.

Experiments were carried out with the helicon discharge reactor [1]. In this reactor, dust particles were produced due to interactions between helicon deuterium plasmas and the graphite target. The total discharging period for dust collection was 100 s. Dust particles were collected using a vacuum collection method just after deuterium plasma operation [2]. Dust particles were collected on the TEM grid and polycarbonate membrane filter at 111 mm below the center of the plasma column. The dust particles on the TEM grid and polycarbonate membrane filter were observed with a TEM and a SEM, respectively. The composition of the dust particles was analyzed by EDX.

The dust particles can be classified into small spherical particles below 400 nm in size, agglomerates whose primary particles have a size of about 10nm, and large dust particles 50 nm to 6 μm in size. The major composition of these dust particles is carbon, which is the primary component of the graphite target. There are three possible formation mechanisms of dust particles: CVD, agglomeration due to electrostatic process, and flaking from the graphite target. Figure 1 shows a representative size distribution of the dust particles of the three types. The size distributions of the small dust particles and agglomerates are well expressed by the Junge distribution while the large dust particles are not. These results indicate that the small dust particles and agglomerates grow in the gas phase, on the other hand, the large dust particles do not. These features of the dust particles are almost same as those obtained through the hydrogen plasma operation [1], indicating that the dust formation mechanisms due to the interaction between a carbon wall and a plasma of deuterium, which is the isotope of hydrogen, is probably similar to those of hydrogen. Such dust particles are probably also formed in deuterium due to the plasma – carbon wall interaction in the LHD.

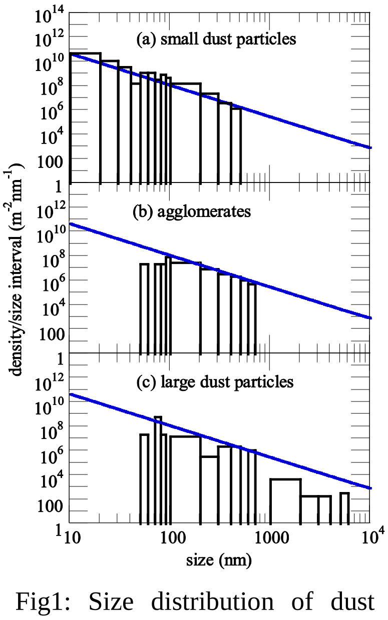

Fig1: Size distribution of dust particles collected using the vacuum collection. The solid line shows the Junge distribution.

[1] S. Iwashita, et al., J. Plasma Fusion Res. SERIES 8 (2009) 308.
[2] J. P. Sharpe, et al. J. Nucl. Mater. 313-316 (2003) 455.