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水素プラズマとグラファイト壁の相互作用により発生するダスト粒子の輸送

Transport of dust particles generated due to interaction between H_2 plasmas and graphite wall

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In fusion devices, dust particles produced due to plasma wall interaction may become safety hazard due to tritium retention and their chemical reactivity. Dust particles also may cause deterioration of plasma confinement [1]. Therefore, the maximum quantity of carbon dust particles in International Thermonuclear Experimental Reactor is limited below 6 kg [2]. So far, we have developed a divertor simulator using helicon discharges to study generation and transport mechanisms of dust particles. Using the discharges, we have found generation of dust particles in nm size due to interaction between plasmas and graphite target, which is a divertor material in Large Helical Device in National Institute Fusion Science, Japan [3,4]. Here we collected dust particles in the divertor simulator to discuss mechanisms of dust transport from dust generation region toward the reactor wall.

Experiments were carried out with the divertor simulator [4]. H_2 gas was supplied at a pressure of 5mTorr. The discharging period was 0.25 s, and the interval was 1.0 s. Dust particles were produced due to interactions between a graphite target and H_2 plasmas. Dust particles were collected on c-Si substrates set in the radial direction on a Ti holder placed at z=25 mm from the target and r =60, 80, 100, 120, and 140 mm from the center of plasma column. The surface of substrates faces the graphite target (target side) and discharge tube (back side). The inner radius of the reactor is 133 mm and substrates at r =140 mm were set in the port. The size and shape of the dust particles collected on the substrates were measured with a scanning electron microscope.

Collected dust particles can be classified into two kinds: spherical particles and flakes. We have obtained the dust flux Γ_d of spherical particles and flakes toward the substrate, which is obtained by n_s/t_{total}, where n_s and t_{total} are the area density of dust particles with size range between 50 nm and 1 μm and the total discharging period (581 s), respectively. Fig. 1(a) shows distance dependence of dust flux. No spherical particles are observed at r = 120 and 140 mm on back side. As shown in Fig. 1(b), the ratio of dust flux towards back side to target side decreases with increasing r =60 to 100 mm. The flux ratio of flake dust drastically decreases by 1.5 order of magnitude with increasing r=100 to 120 mm. It suggests that transport mechanisms of dust particles near the vessel wall differ from in the middle of the vessel.

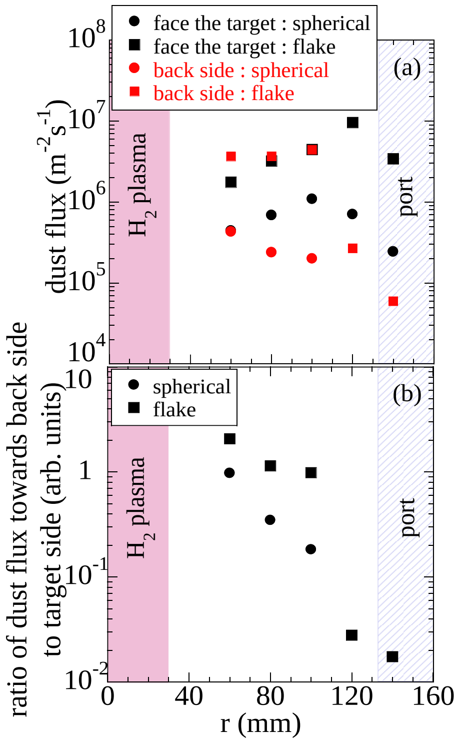

Fig. 1. (a) Distance dependence of dust flux, (b) Distance dependence of ratio of dust flux towards back side to target side.

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