Characteristics of dust particle injected into fusion plasma

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In recent years dust injection experiments into fusion plasma were carried out and planed to investigate the dust characteristics, where the sizes of dusts are as larger as 10 μm or more. According to the OML model [1] the charging time of a dust with a radius 10 μm is 1.02×10^{-9} sec in the case of n_e = 10^{19} m^{-3}, T_i = T_e = 1 keV and $u=\left|\vec{V}_i-\vec{v}_d\right|/v_{th,i}$ = 1, where u is the relative speed of ion flow $\vec{V}$ to the dust $\vec{v}_d$ normalized by the ion thermal speed $v_{th,i}(=\sqrt{2T_i/m_i})$. This time is so fast compared to that of the dynamics in typical fusion plasma, which means we can use the equilibrium charge during the dynamics in plasma [2]. The equilibrium charge is determined as a form of Z_d / R_dT_e as a function of temperature ration T_i / T_e and the normalized relative speed u. The charge state Z_d is as high as 1.74×10^7 in the case of R_d = 10 μm and T_e = 1 keV.

In this study we focus the change of injected dust temperature. For the first step we investigate the maximum temperature of a dust particle during crossing the cylindrical plasma with a constant speed. The temporal evolution of dust temperature is estimated from that of dust enthalpy [3,4]. In Table 1 the maximum temperatures of dust (carbon, iron and tungsten) with the radii of 10 and 100 μm are shown, where the upper and lower numbers correspond to n_{ec} = 10^{18} m^{-3}, T_{ec} = 100 eV and 10^{19} m^{-3}, 1 keV, respectively. Here n_{ec} and T_{ec} are the electron density and the temperature at the center of plasma column. The plasma with high quality heats the dust over the melting temperatures T_{fus}.

The detailed dynamics in toroidal plasma and behaviour of dust temperature have to be investigated. These results might be useful to the dust injection experiments into toroidal plasma.

Table 1 Maximum dust temperatures of carbon, iron and tungsten
in the plasma with n_{ec} = 10^{18} m^{-3}, T_{ec} = 100 eV and 10^{19} m^{-3}, 1 keV, respectively.

	R_d = 10 μm	R_d = 100 μm
C : $T_{fus}\sim3.8\times10^3$ K	6.16×10^3 / 2.72×10^4 K	1.53×10^3 / 2.72×10^4 K
Fe : $T_{fus}\sim1.8\times10^3$ K	5.76×10^3 / 2.08×10^4 K	1.18×10^3 / 2.08×10^4 K
W : $T_{fus}\sim3.8\times10^3$ K	4.93×10^3 / 2.10×10^4 K	4.24×10^3 / 2.08×10^4 K

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