§22. Electric Field at Plasma-Facing Wall for Double Electron Temperature

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Electric field at a plasma-facing wall is studied analytically in the case of electrons with double temperature. The models are as follows: *a*) magnetic field is applied to the surface normal, *b*) velocity distribution function of ions at the entrance of Debye sheath is assumed to be shifted-Maxwellian, *c*) the potential at the plasma-facing wall is floating. The Boltzmann relation to the electron distribution and the flux and energy conservation in the Debye sheath of ions give the each density as a function of the electrostatic potential. By using the Poisson's equation the local electric field inside the sheath is expressed by the local electrostatic potential.

The floating wall potential drop is determined of the equal condition of the ion and electron currents. In Fig.1 the floating wall potential drops normalized electron temperature of cold component T_{ec} are shown as a function of electron temperature ratio for the cases electron density component to the total electron density at the sheath entrance. In the case of electrons with high-energy component such as double temperature, the potential drop inside the sheath is enhanced in order to prevent the electron current with high energy under the floating condition.

The increment of the potential drop - ϕ_w makes the electric field at the wall E_w increase. In Table 1 the increases of - ϕ_w and E_w are shown for the cases of $T_i = 0$ and $n_{eh} / n_{se} = 0.01$, 0.03 and $T_{eh} / T_{ec} = 10$, 30, where T_i, n_e and T_e are the ion temperature, electron density and temperature at the sheath entrance, respectively. The suffixes *c* and *h* indicate the cold and hot component of electrons, respectively. The quantity n_{se} is the electron density at the sheath entrance and - ϕ_{w_0} and E_{w_0} are the values in the case of $n_{eh} / n_{se} = 0$.

The effect of finite ion temperature is shown in Fig. 2, where the change rates of E_w to the value of $T_i = 0$ are drawn. The straight, long dashed, short dashed and dotted lines are (n_{eh} / n_{se}, T_{eh} / T_{ec}) = (0.01, 10), (0.01,30), (0.03,10) and (0.03,30), respectively. The changes doe to finite ion temperature are few percentages for the case of lower ion temperature than that of cold component.

These results might be available to the study of the phenomena near the plasma-facing wall such as release of dust particle from the wall and the reflection of dust particles near the wall.

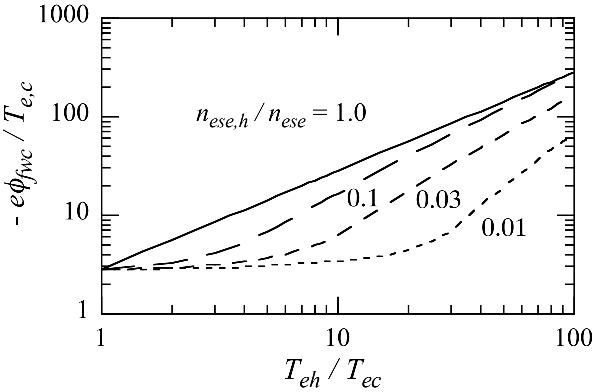

Fig.1 Floating wall potential drops ϕ_{fwc} normalized electron temperature of cold component T_{ec} as a function of electron temperature ratio T_{eh} / T_{ec} for the cases electron density component to the total electron density at the sheath entrance.

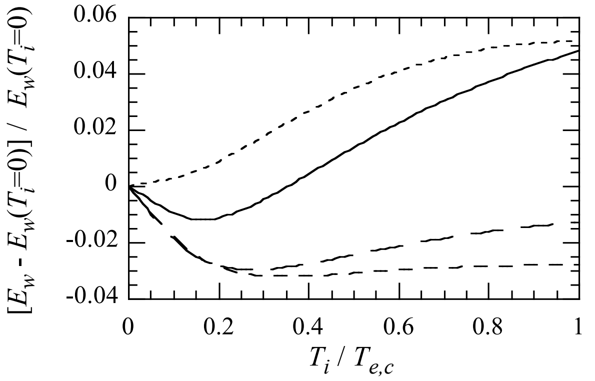

Fig. 2 Effects of finite ion temperature to the electric field at the plasma-facing wall.

Table 1. Effects of hot electron component: wall potential drop ϕ_w and electric field E_w

n_{eh} / n_{se}	$-\phi_w$ (T_{eh}/T_{ec}=10) / - ϕ_{w_0}	$-\phi_w$ (T_{eh}/T_{ec}=30) / - ϕ_{w_0}	E_w (T_{eh}/T_{ec}=10) / E_{w_0}	E_w (T_{eh}/T_{ec}=30) / E_{w_0}
0.01	1.167	1.578	1.097	1.308
0.03	1.915	10.76	1.443	2.859