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Electric field on the surface of a metal electrode immersed in plasma at a high negative potential

V. A. Ivanov

Prokhorov General Physics Institute of the Russian Academy of Sciences
38 Vavilov st., Moscow, 119991, Russia
E-mail: ivanov@fpl.gpi.ru

An analytical solution of the Poisson equation is found for calculating the electric field on the surface of an electrode immersed in a homogeneous non-isothermal collisionless plasma consisting of electrons and single-charged ions with charge e, with electron temperature T_e, at large values of negative electric potential Ψ, when the parameter $|e\Psi/T_e >> 1$. It is established that the size of the plasma layer L with disturbed quasi-neutrality near the high-potential electrode increases in comparison with the Debye radius r_D in proportion to the parameter $[e\Psi/2T_e]^{3/4}$, $– L= r_D [e\Psi/2T_e]^{3/4}$. It is shown that in a laboratory plasma with a density in the range of $10^{10}–10^{13}$ cm^{-3} and an electron temperature from 1eV to 10 eV at high values of the potential and parameter $e\Psi/T_e >> 1$, the electric field calculated by the obtained formula $E = \Psi|L$ near the surface of the electrode immersed in plasma, from 20 to 200 times less than the values of the fields calculated by the classical formula $E = \Psi|r_D$, obtained at low potentials and at the values of the parameter $e\Psi/T_e << 1$.

Keywords: plasma, electrode, high electric negative potential, Poisson's equation, electric field, modified Debye radius.

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