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Generalized formula for calculating the electric field on the electrode surface in plasma

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On the surface of a metal electrode immersed in a plasma with an electron temperature $T_e \sim 10$ eV and a plasma density n_e from 10^{10} cm^{-3} to 10^{13} cm^{-3} the electric field of the electrode is calculated under the negative electric potential Ψ_0 at large values of the dimensionless parameter $|e\Psi_0|/T_e >> 1$.

The resulting asymptotic formula for the field strength at $|e\Psi_0|/T_e >> 1$ differs significantly from the classical formulas for calculating the electric field and the Debye length near the electrode surface in plasma, which are valid under the condition $|e\Psi_0|/T_e << 1$. It is shown that at $|e\Psi_0|/T_e >> 1$ a modified Debye layer in the plasma near the electrode can exceed the classical Debye length by two orders of magnitude. To calculate the electric field on the electrode surface in plasma a generalized formula is proposed explicitly, which is valid in a wide range of values of the parameter $0 < |e\Psi_0|/T_e < 10^3$ at negative values of the electrode potential up to 10 kV.

Keywords: plasma, electrode, negative potential, Poisson's equation, electric field, modified Debye length, generalized formula for electrical field calculation at electrode.

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