CALCULATION OF THE ELECTRIC FIELD ON THE ELECTRODE SURFACE FOR HIGH POTENTIAL VALUES IN A LABORATORY PLASMA [[1]](#footnote-1)\*)

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It is known that the magnitude of the electric field on the electrode surface in plasma plays a significant role in the development of various types of discharges. It is usually assumed that in plasma, when studying the formation of a layer with the separation of electrons and ions near an electrode under a negative potential Ψ0 and immersed in a plasma with a volume density of charged particles *n* and an electron temperature *Te*, the condition of small values of the potential *e*Ψ0/*Te* <<1 is satisfied, where *e* is the electron charge. For the plane case, the solution of the Poisson equation  determines the magnitude of the electric field *E*0 on the electrode surface , where  is the classical Debye radius. In this case, the well-known formula  for the Debye screening of the field in plasma is obtained. At high values of the electric potential of the electrode in the plasma *e*Ψ0/*Te*>>1 the situation changes dramatically. The Poisson equation will take the form , from which the solution for the magnitude of the electric field on the electrode surface follows in the form:  [1]. The parameter *L* can be called the modified Debye radius, which is equal to the product of the classical Debye radius  and a large value . Under conditions when *e*Ψ0/*Te*>>1 the modified Debye radius *L* can be 2 orders of magnitude greater than the classical Debye radius radius . Calculations show that for laboratory plasma with electron temperature =10 eV and density *n=*(1010−1013) cm−3 the value of the modified Debye radius can be 30–180 times greater than the classical Debye radius, and, accordingly, the electric field on the surface of the negative electrode will be 30–180 times less than the field calculated by the classical formula. So, for a plasma with a density of 1013 cm−3 and a temperature of =10 eV, at an electrode potential of 1000 V, classical formulas give values for the Debye radius ≈7.5 μm and electric field strength *E*≈1.35 MV/cm. In this case, the value of the modified Debye radius is *L*≈235 μm, and the magnitude of the electric field on the electrode surface is reduced to the value of *E*≈75 kV/cm.

References

1. V.A. Ivanov. Electric field on the surface of a metal electrode immersed in plasma at a high negative potential. // Uspehi prikladnoi fiziki, 2022, V. 10, No. 4, Pp. 343-350. [in Russian] DOI: 10.51368/2307-4469-2022-10-4-343-350
1. \*) [abstracts of this report in Russian](http://www.fpl.gpi.ru/Zvenigorod/L/Lt/ru/FZ-Ivanov.docx) [↑](#footnote-ref-1)