TUNNEL CHARACTERISTICS OF THE METAL TIP-CATHODES WITH THE SUPERTHIN DIAMOND COATS IN THE COMPARISON OF THE CLASSICAL AND NON-LOCAL CONSIDERATIONS

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ABSTRACT

We have executed the precise solution of the Schrodinger equation for the electron tunneling through the potential barrier of the arbitrary shape and have received algorithm of calculation of the transparency coefficient. Using the obtained algorithm we have computed relation of the transparency coefficient for the potential barrier for classic and with the taking into account non-local effects for the metal tip cathodes and with super thin diamond coats.

I. INTRODUCTION

Recently, for field emission devices the diamond films are considered as a cold cathode materials because the diamond coats results in improving current-voltage characteristics of baseline cathodes. For comprehension of processes, which one result in such effects the in-depth analysis of the physical model of the heterophase structure is necessary. For this purpose the precise knowledge of a potential barrier and precise calculation of the transparency transparency coefficient of its is necessary.

II. APPROACH

In this article we consider the diamond film as the dielectric coat (n-type weakly doped diamond with the bulk concentration $n_2 \sim 9 \cdot 10^{10} cm^{-3}$), when Fermi level in the film correspond to the Fermi level in the metal. In this case the contact potential is zero and the potential barrier at the internal interface is absent. The following paramrters were used: temperature is $T = 293° K;$ for the tungsten: $n_1 = 4 \cdot 10^{22} cm^{-3}$ and $m^* = 0.7759 m_0$ are the concentration and effective mass of the free electrons;, $\varphi_{met} = 4.6 eV$ is the work fuction; for the film of the (*n*-type) diamond: dielectric constant is $\varepsilon = 5.6$; effective masses are $m_\perp = 0.36$ (transverse) and $m_l = 1.4$ - (parallel); electron affinity in the bulk

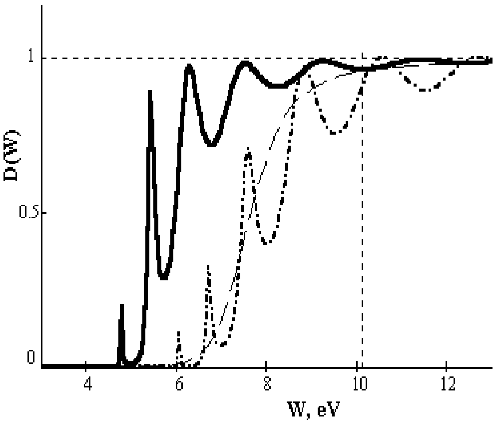

Fig. 1

is $\chi = -E_c = 3.34 eV$, where E_c is the bottom of conduction band. Taking into account the space dispersion effects in the diamond film and in the metal and the field penetration into superthin dielectric films the potential barrier had been calculated. We supposed that the electrons emit from the metal substrate through the very thin dimond film. The transparence $D(w)$ of the potential barrier in the case of the metal surface (dashed curve) and with the diamond coat by thickness $L = 15 \overset{o}{A}$ (solid curve) is compared in Fig.1 for the external electric field $F = 5.10^7 V/cm$. The transparence $D(w)$ of the potential barrier calculated according to the classical consideration (local electrostatics) are shown in Fig.1 by the dash-dotted curve.

III. CONCLUSION

Investigations which were carried out open the way for direct calculation of the concrete current-voltage characteristics as the function of the concrete thickness and concrete properties of the diamond film and the analysis of the electrons distribution on energies, that is important for the analysis of the technological processes of the tip emitteres manufacturing.