FIELD PENETRATION POTENTIAL INTO THE SUPERTHIN DIELECTRIC FILM

Lyudmyla G.Il'chenko[1] and Vasyl V. Il'chenko[2]
[1]Institute of Surface Chemistry NAS of Ukraine, Generala Naumova st.17, Kiev, 03164,
[2]Radiophysical Dept., Kiev University, Volodimirska st. 64, Kiev, 02033, **UKRAINE**

ABSTRACT

The selection of the optimal parameters for the superthin dielectric films is one of the actual problem of the up-to-date vacuum microelectronics. In the presented report the potential barrier for the electrons tunneling from a metal through the very thin dielectric coating to the vacuum in the external electric field is calculated. The theoretical solution in the framework of nonlocal electrostatics taking into account the space dispersion effects in the metal and dielectric film has been found.

1. INTRODUCTION

The dielectric films on the metal (or semiconductor) surface lead to the chemical stabilization of the surface. In this time the emission characteristics of these layered cathodes change with respect to the base material. So the problem of an optimality of the thickness of dielectric cover can not be solved without precise knowledge of the relation of the shape of the potential from the thickness of the film, that is from penetration of the external electrical field in it.

II. THEORETICAL CONSIDERATION

In this work the dielectric function of the metal substrate we set in the Thomas-Fermi approximation and the dielectric function of the thin dielectric coat we set in the Inkson interpolation model which is taking into account the nonlocal screening effects by the dielectric lattice of the connected electrons [1]. The analitical expression for the field penetration potential $\Delta V_j(x,F)$ into superthin dielectric film is calculated. It is shown that the external field penetration potential $\Delta V_j(x,F)$ into the dielectric film is determined both by classical term and the items that determine screening nonlocal effects in the dielectric coating and in the metal substrate [2]. With the increasing of the dielectric film thickness L their contribution weaken and the field term variation $\Delta V_j(x,F)$ speeds to the classical expression. In the present work $\Delta V_j(x,F)$ is calculated in the dependence on the thickness L and its parameters: static dielectric permitivity and the atom (molecule) dimensions forming the dielectric matrixes lattice. The calculated barrier $V_j(x,F)$ and the classical potential barrier $V_{cl}(x,F)$ is compared.

III. CONCLUSION

The obtained potential distribution of the external electrical field penetration into the dielectrics film (on a surface of metals and semiconductors) allows to receive the precise shape of the potential barrier for electrons, which one tunneling through the dielectric film into vacuum. The conducted consideration is specially important for the super thin (down to several monolayers) dielectric coatings.

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