The Influence Cylindrical Nano Defects Filling Volume on Heat-Resistant Metals Thin Films Effective Electronic Characteristics

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Diagnostics and control of the parameters of the samples with NDFV are conducted with the help of different methods of metering of effective carrier density in the sample that represents the material under study. At the same time, the kinetic processes such as conductivity current in the sample with NDFV, lead to the change in the mictrostructure of the local electrostatic field and the redistribution of carriers in the region of local thermodynamic equilibrium. It is reflected in the behavior of the effective conductivity of microinhomogeneous sample (MIS), so the interpretation of the experimental data needs to take into account these effects. As it was shown in [1-5], the self-consistent exchange of electric charge between the base material (BM) and the NDFV subsystem happens in the way that the instantaneous electroneutral regions (electroneutral cells) emerge, transform and evaluate in the volume of MIS. They define the spatial scale of the coulomb microinhomogeneties of the sample. Their emergence is caused by the presence of non-zero effective density of the electronic component inside the ND volume. The statistical averaging on the system realizations ensemble within the framework of Thomas-Fermi approximation for the carrier dispersion equation gives the effective distribution of space charge and self-consistent electric field in the electroneutral cell C_ξ^z of MIS. The C_ξ^z cell is the result of the averaging of the instantaneous cell C_ξ over the cell ensemble $C_\xi^z = \mathrm{mean}\{C_{\xi n}\}_{n\to\infty}$. Further averaging of the of the local parameters for multiple statistical cells of the sample leads to the determination of the effective electrochemical potential F of the carriers in microinhomogeneous film and associate it with the initial thermodynamic, electronic and dielectric parameters of the MIS, external electric field $\vec{E}_0$, geometric characteristics of the NDFV and collective parameters of the defect microstructure dispersed in the sample.

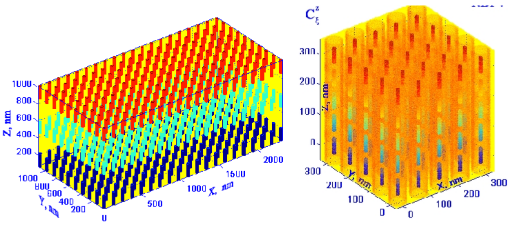

Fig.1. Electroneutrality cells in the nanoinhomogeneous film sample of the heat-resistant metal with cylindrical NDFV: A) three-layer film; B)the microinhomogeneous film element with cylindrical defects of filling volume in the electroneutrality cells .

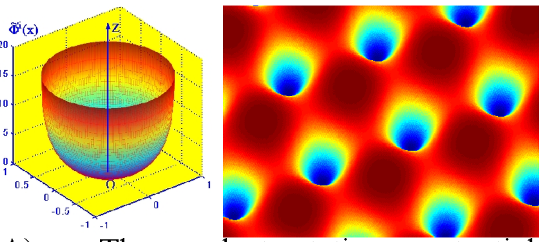

Fig.2.A). The electrostatic potential distribution in its own volume NDFV. The potential is normalized to the Fermi energy of the carriers of the base material film, the geometrical parameters are expressed in units of the Debye radius; B). The cross-section of a super lattice of cylindrical NDFV in a thin film in Wolfram. In conditi-onal colors presents a qualitative picture of the distri-bution self-consistent potential in the vicinity of defects. Red represents the BM-matrix, a blue region volumes nanodefects with a low concentration of carriers.

The most commonly used in applications types of film structures with defects of filling volume is shown in figure 1.

The spatial distribution of the self-consistent electrostatic potential in the individual volume of the defect, and in a thin film with a regular structure cylindrical NDFV demonstrate Fig. 2A) and Fig. 2B) .

3-D the dependence of the effective Fermi level of carriers in Fig. 3 reflects the effect of size and concentration of RDSO in a film of tungsten on the effective work function of electron transfer from the surface.

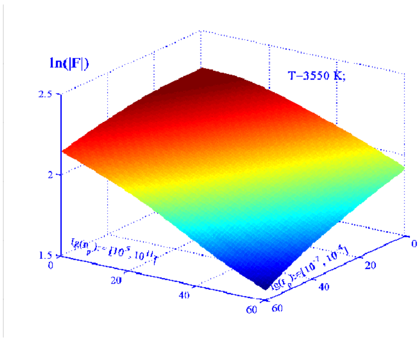

Fig.3. The effective Fermi level of carriers in micro-inhomogeneous film.

Conclusions:

1).The problem of the equilibrium ionization in the heterogeneous heat-resistant metal with the nano defects filling volume (NDFV) is solved in the framework of the statistical model of the quasi-neutral cells of heterogeneous plasma for the planar and cylindrical symmetry of the nano-inclusions in the matrix of base material of microinhomogeneous sample (MIS); 2).The functional dependencies of the effective NDFV charge and its Fermi level on the thermodynamic parameters of microinhomogeneous sample (temperature, size and concentration of defects, initial electronic and dielectric properties of the base material) are determined with the help of the averaged on the cell ensemble parameters of the microinhomogeneous sample with the defects filling volume; 3).The analytic equation, that determines the optimal relation between the NDFV geometry and the walls of base material matrix in case of maximum defect influence on the electronic properties of the sample, is obtained;.4).The structure of the local Maxwell field in the wall region of VFD and local volume charge distribution in the contact area between base material and defect are determined. The effect of the tension of the self-consistent electrostatic potential on the effective work function of electrons from the surface of the micro inhomogeneous films with nano defects of filling volume; 5). The computer simulation of the electrophysical properties of wolfram, rhenium, tantalum and microinhomogeneous aluminum oxide with VFND was performed in the temperature region T=[1000,3000]K, which is characteristic for the contemporary technologies of high-temperature plasma sensors.

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