Nanostructured surfaces
Mechanical and thermodynamic parameters in Si - metal structures for micro- and nano-electronics

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Contacts of Si – metals are widely used as base elements of microelectronics and some sensor converters. However, the operating time and stability of their parameters are determined by the nature of interfacial interactions on the surfaces of metallic condensate and silicon substrate. In addition, the formation of stable heterophase nanostructures for nanoelectronics needs requires the specific information about the properties of interacting surface layers such as quantitative values of thermodynamical and adhesive parameters.

The aim of this work is to analyze the interfacial interactions and calculation of energy and adhesion parameter on monocrystalline silicon - metallic nanocondensate (Cr, Cu, Al and Au).

The behave of mechanical stress on the interface of "Si substrate – metal condensate" based on the kinetics experimental dependence of the internal stress were investigated. The Si substrate self-organizing role in creation of mechanical stresses in nanocondensates was found. It was supposed that during growth of nano condensates the degree of substrate self-organizing role is determined by the difference of electronegativity between substrate and nanocomposite.

The external and internal size effects of internal stresses and Young's modulus of copper condensates on the surface of monocrystalline silicon were found. The kinetics of internal stresses in the metal condensates is determined by the change of interphase energy parameters such as interface stresses in the "substrate – nanocondensate" and by the phase generation process because of surface energy variation in the volume of condensate during it's deposition. The total internal stresses, which were found experimentally by console method, in the metal condensate are the total action of statistical local stresses destitution on the film surface due to anisotropy of energy parameters of the interfacial interactions in condensed plane. The range of deposition rate (0,2 ÷ 0,5 nm/s) of copper condensates on monocrystalline Si-substrate were characterized by abnormal variations in mechanical stress. It happens because of the variation of mechanical modules and grain size in copper condensate. The fabrication technique of the metal films with predictable levels of own and thermal stresses were proposed.

It was found that the most sensitive parameter in the analysis of interfacial interactions in the "Si – metal" is the interfacial energy, which for the investigated number of metals very in 4 times. The peculiarity of the investigates interfaces is a permanence of interfacial charge, due to the structure via a covalent bond formed in the interfacial layer.