The Electronic Structure in the Transition d-Metal Films of Nanometer Thickness

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The electron kinetic size phenomena in thin metal films give us useful information about the evolution of electronic structure of limited size samples such as transition *d*-metal films. It is interesting to determine the minimum film thicknesses after which electronic structure of sample are identical of bulk metal electronic structure. Setting the limits of theoretical models suitability which describe size kinetic phenomena in metal film thermoelectric power allow to estimate the critical films thicknesses at which electronic structure of the samples are changed. The investigation of transition *d*-metal such as Ni, Pd and Cr electrical conductivity, thermoelectric power size dependence and structure had allowed to get valuable information about critical film thickness after which the energy band structure became similar to electronic structure of bulk material.

The preparation and electron kinetic parameters investigation of metal films were conducted under ultrahigh vacuum conditions (residual dynamic gas pressure ~ 10^{-7} Pa) in metal experimental devices. Similar to [1] technique was used. The investigated metal film were deposited on glass substrate at 78 K (clear or coated germanium underlayers with mass thickness of 1-2 nm) with speed deposition 0,1-0,2 nm/s by condensation of thermally evaporated metal. The control of germanium underlayers and metal film thicknesses were performed by shift of quartz vibrator resonance frequency placed in the metal vapor flux. After deposition metal films were thermostabilized to room temperature to improve it's structure and electrical properties.

The experimental dependence of the resistivity $\rho = \rho(d)$ and temperature coefficient of resistance $\beta = \beta(d)$ can be quantitatively described by polycrystalline inhomogeneous layer thickness model [2]. It was shown that germanium underlayers reduce crystallites linear sizes of metal films and have effect on the electron transport properties of them. Deep analysis of resistivity and thermoelectric power size dependences of deposited on germanium sublayers metal films show that the dimensional dependence was well described by a model of two independent groups of current carriers with different effective masses. It was shown that in the case of palladium film with average linear sizes of crystallites D = 10 nm, the ratio between the conductivity of different groups of charge carriers is $\sigma^+/\sigma^- = 0{,}8$ and for palladium films deposited on germanium sublayers with mass thickness of 0,5 nm; $\sigma^+/\sigma^- = 0{,}75$. It was found that critical mass thickness after which electron structure become identical to bulk metal electron structure is compiled in electrically continuous palladium films close to 5 nm. This result had good agreement to [3].

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