Nanoscale Physics

Transport of Q1D electrons over superfluid helium in potential wells with linearly charged substrate.

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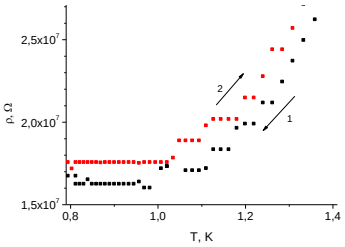
The great progress in nano-technologies of solid materials has lead to creating a Q1D conducting systems. The charge carries here free move in one directional only and others charge displacement are quantized. The study of Q1D system in semiconductors motivated creating this one based on the surface electrons (SE) over superfluid helium. The advantages of SE's here are high homogeneity and the possibility of a wide variation the carriers concentration and width of conducting strip. This system was realized over helium in grooves of linearly profiled dielectric substrate [1] and detail theoretically in [2]. In this work the electrons from a source at the clamping field, $E_\perp$ are emitted first to the substrate forming charged lines near grooves and then into grooves with helium for forming strips of SE-s. The depth of potential well for SE-s estimated as $\varphi_1 = e\,E_\perp\,\delta$ (δ is the distortion size of liquid surface in groove) increases by the potential of charged lines of substrate, $\varphi_2 = (\tau/2\pi\varepsilon_0)\cdot ln\,(1/r)$ (here τ is charge density of lines, r is distance from line and ε_0 is dielectric constant). The frequency of harmonic spectrum and electron localization size in Q1D system are $\omega_0^2 = eE_\perp/(mR)$ and $y_0^2 = \hbar/(2\pi m\omega_0)$, accordingly (where R is radius of curvature of liquid in groove and $\hbar$ is Plank's constant). The **figure** demonstrates resistance ρ vs temperature T (the arrow 1 at lowering T and arrow 2 at raising T). Differences curves 1 and 2 caused by relaxation time of the substrate charges. Notice the electron into liquid helium is bubble. As can see the lower than 1.2 K the dependences manifest step behavior. This can be caused by the quantum -size effect with energy spectrum $n\cdot\hbar\cdot\omega_o$.



1. *Yu. Z. Kovdrya and V.A. Nikolaenko*. Quazi-one-dimensional electronic system over liquid helium //Fiz. Nizk.Temp.–1992.-**18**.- P.1278-80.
2. *S.S. Sokolov, Guo-Qiang Hai and Nelson Studart*. Mobility of electrons in Q1D conducting channel on the liquid-helium surface //Phys. Rev.B. -1995.-**51**.-P.5977-88.