The Conductivity Dip-effect of Quasi-one-dimensional Electrons over Superfluid Helium

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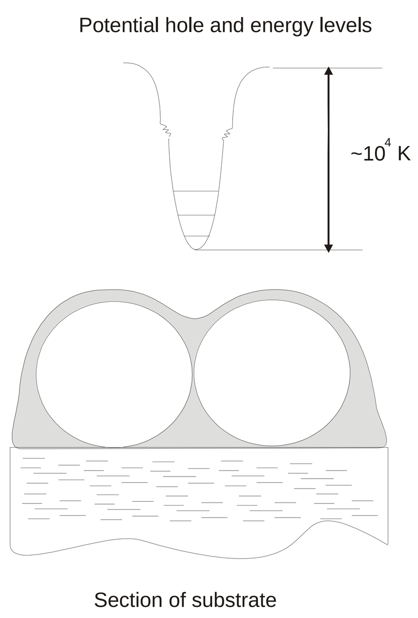
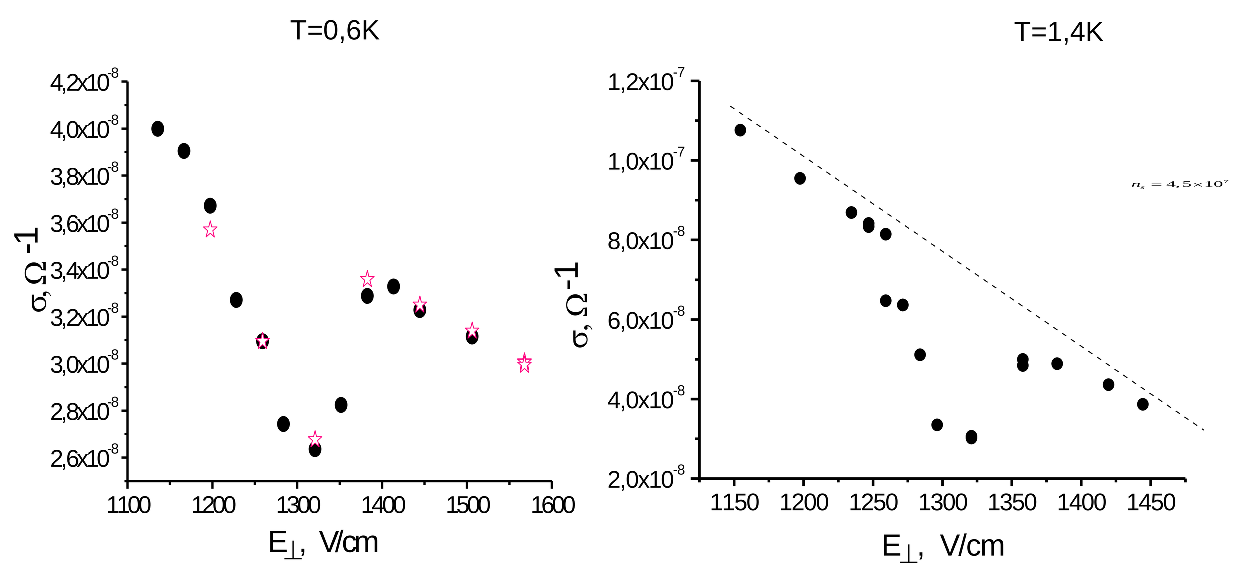
Introduction. The specific effects in quantum-size systems over superfluid helium is good expressed at low *T* [1].

The quasi-one-dimensional surface electrons (Q1D-SEs) conductivity over helium in grooves between rows dielectric threads is investigated. Experiments was carried out with use nylon threads 100 μm in diameter at temperatures 0.5-1.5 K by scanning of electric field, *E* in the range 1.1 – 1.6 kV/cm.

Setup and first results



Setup. The measurements performed at low frequency by a technique using capacitive coupling of two electrodes with electron subsystem (section of profiled substrate on figure).



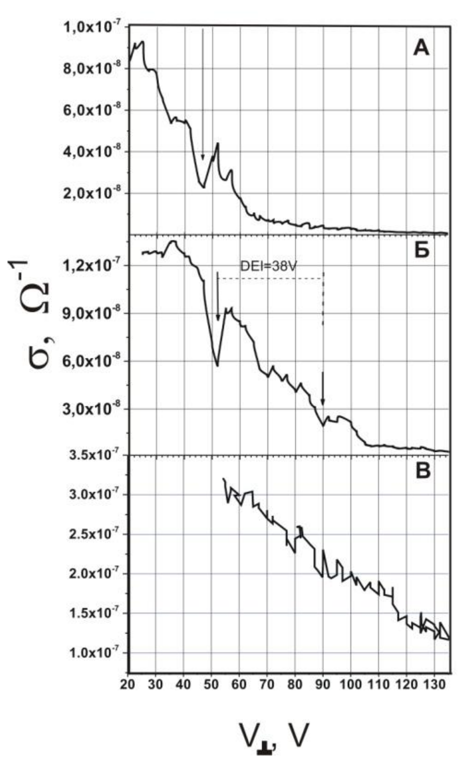
Detailed research is shown the **dependence** *σ* - dip from radius (R) curvature of liquid between the threads: A –2.85·10^{-3} cm; B – 6.4·10^{-3} cm; C - 2·10^{-3} cm; D – 3.7·10^{-3} cm. The SE density is 4.5·10^{7} cm^{-2} and T ≈ 1K. (See 'analyze' section)

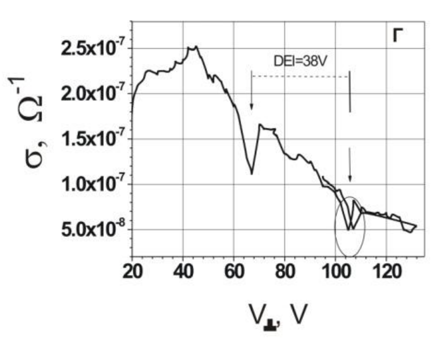
First results At SE concentration 1.7 cm^{-2} was considered electric field dip- effect of conductivity. Position min of effect has a place near 1.35 kV/cm and **independent** temperature at list in range 0.5 – 1.4 K.

Analyze

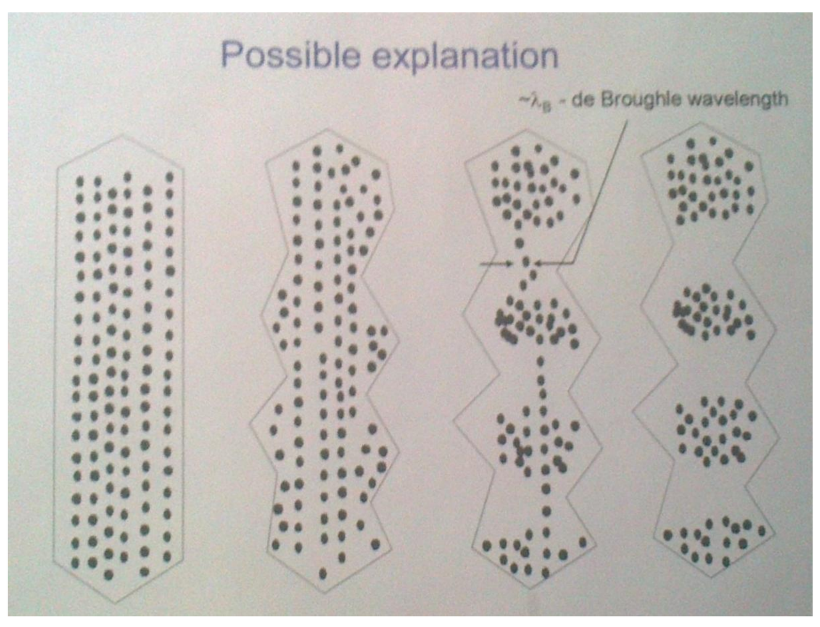
Difference of levels between substrate and helium, *h* set the curvature radius of liquid in grooves $R = \sigma / (\rho \cdot g \cdot h)$ (here *σ* and *ρ* are surface tension and density of superfluid helium; *g* is gravity constant) which typically was 35 μm.

The harmonic spectrum a 1D system in parabolic potential well $e \cdot E \cdot \delta$ (here *δ* is the helium surface deflection in groove) is $\omega^2 = eE/(mR)$.





The qualitatively explanation can be next. The conducting stripe at not smooth substrate at relative large *E* is divided on segments and in this moment takes a place electron percolation through quantum size distance (accompanied by noise in experiment). →



Conclusion

In conclusion must be noted, the dip-effect not depend from temperature or parameters the measurement signal and disappear at both the large radius, *R* and very smooth and very rough the substrate surface.

The conductivity dip-effects has been observed in 2D SE on helium film with a weakly rough substrate [2].

References

1. *Ginzburg Vl.L., Monarkha Yu.P.* Surface electrons in helium over macroscopic structures // Fiz. Nizk. Temp. – 1978. – **4**. -P. 1236-1239.
2. *Leiderer P., Nazin S., and Shikin V.* Dip-effect in the conductivity of 2*D* electrons on a helium film with a rough substrate// Fiz. Nizk. Temp. -2008, - **34**, - P.489–495