Acousto-Electric Effect in a Gold Nanowire

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Background, Motivation and Objective

The investigation of interaction of acoustic phonones and electrones in hybrid devices, where piezoelectric crystal is a substrate for low-dimensional nanostructures has a great fundamental and practical meaning. The different mechanisms of electronic transport like diffuse, ballistic, tunnel or single-electron could be realized in the low-dimensional electronic nanostructures. The displacement of lattice atoms due to acoustic wave leads to change of intercrystallic fields. This is leads to change of allocation and movement character of conduction electrons in the corresponding electronic nanostructures. The acoustoelectric effect originates from carry away of current carriers by an piezoactive acoustic wave. This effect has recently attracted the attention of researchers as possible method to control the motion of massive objects in the quantum regime. It is possible to use this effect for development of high sensitive acoustonanoelectronic sensors. The sensitivity could be increase through the use of modulation mode of operation based on the acoustic pilot signal and the transition from quasi-stationary measurement to measurement at the modulation frequency.

Statement of Contribution/Methods

The acoustic delay line based on Y-X $LiNbO_3$ plate was created. The shear-horizontal acoustic wave of zero order (SH_0) with resonant frequency 2.77 MHz was excited in this delay line that consists of two interdigital transducers with 5 pairs of strips. On the surface of the plate between IDTs the nanostructure made by electron photolitography was placed (Fig.1,A).

Results/Discussion

The volt-ampere characteristics (VAC) of this nanostructure in presence and at the absence of the acoustic wave are presented in Fig. 1,B. The analysis has shown that presence of piezoactive acoustic wave is influenced on electric current in a nanowire. The measurements were performed for 3 values of voltage applied to exciting IDT (750 mV, 2.3 V, 7.5V). It has been found that increase in applied voltage leads to increase in the VAC change. It could be explained by increasing capacity of piezoactive wave due to increasing applied voltage. The work is partially supported by RSF 18-49-08005 in frame of development hybrid acousto-nanoelectronic device and RFBR grant 19-07-01091 in frame of development of tunnel nanostructure.

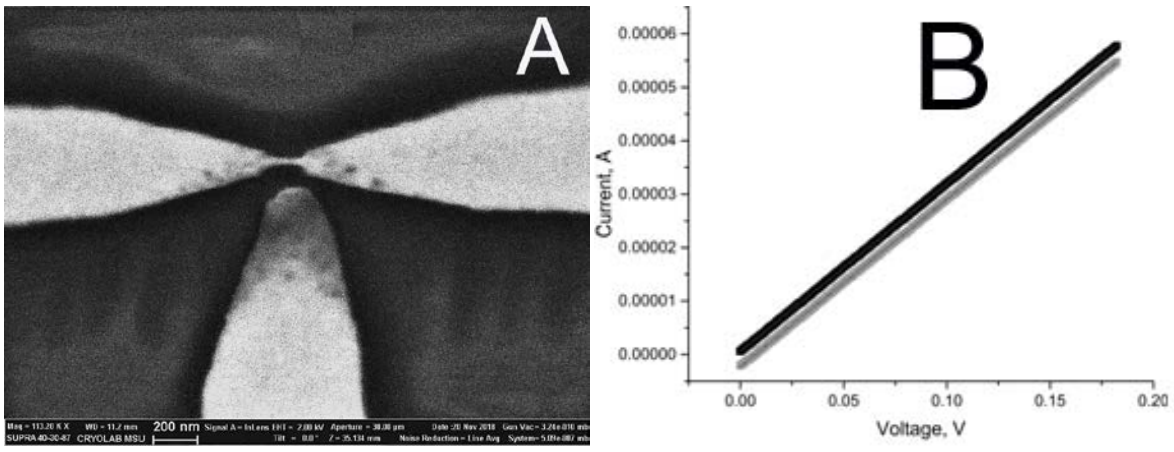

Fig.1. A. SEM image of the gold nanowire. B. Volt-ampere characteristics of gold nanowire at absence (black line) and in presence (grey line) of piezoactive acoustic wave (750 mV)