CHARACTERISTIC FEATURES OF CHARGE TRANSPORT PROCESSES IN $Si/SiO_2/Ni$ NANOSTRUCTURES WITH SWIFT HEAVY ION TRACKS

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A nanostructure n-$Si/SiO_2/Ni$ is created by means of electrodeposition of Ni in pores formed in SiO_2 [1] by chemical etching of swift heavy ion tracks [2-3]. Investigations of electrical-physical properties of the n-$Si/SiO_2/Ni$ structure are carried out in temperature range 18 K to 300 K and magnetic field up to 12 T. Temperature dependences of electrical resistivity (R) and transverse magnetoresistance (R_B) are given in Fig.1. One can observe that R(T) and R_B(T) dependences are qualitatively similar and have a complicated character. They can be conventionally split into three temperature regions. In the region from 300 K down to 210 K a parabolic increase of resistivity takes place which comes to saturation at temperature of about 240 K. A main contribution in the conductivity here is made by electrons from upper energy levels of the Si conduction band and their overbarrier emission in metal takes place. At temperature decrease to 210 K a kink is observed on the dependence, after which resistivity undergoes the parabolic increase again with a tendency to saturation beginning with ~ 60 K. In this temperature region Ni clusters in nanopores do not take part the charge transport process by means of “freezing out” of electron states on upper energy levels and increase of energy barrier on the metal-semiconductor boundary. At temperatures lower 35 K an exponential increase of resistivity is observed which is characteristic to semiconductors becoming dielectrics in this temperature range. The charge transport here is partially carried out through metallic clusters in nanopores and between nanopores it is carried out on the Si/SiO_2 interface. Positive magnetoresistance revealed at low temperature region (from 18 K to 35 K) is justified by this mechanism as well. This magnetoresistance reaches value of 1000 % and it appears due to a partial polarization of electron spins in Ni clusters which leads to exclusion of electron from the conductivity process.

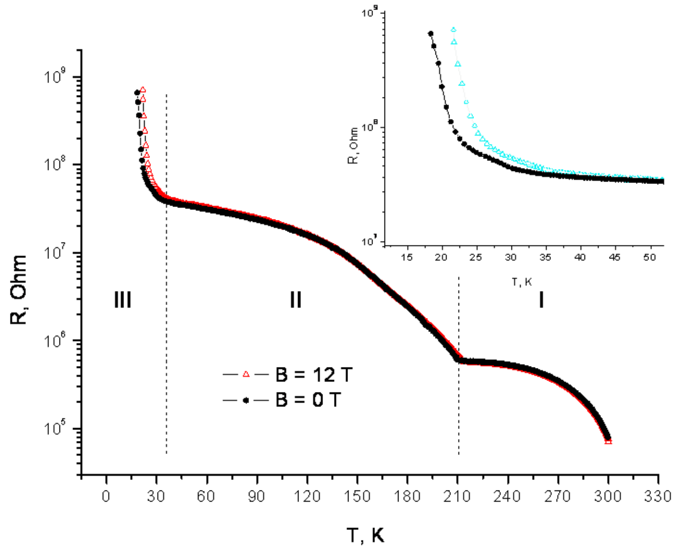

Fig. 1: temperature dependences of resistance in zero magnetic field and magnetic field of 12 T.

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