"Physico-Chemical nanomaterials science"

Impedance of boron and nickel doped silicon micro and nanostructures

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Nowadays low-dimensional semiconducting structures, in particular, Si whiskers allow a creation of highly sensitive piezoresistance sensors of mechanical values (strain, force, pressure etc.) able to work at the temperature of liquid helium [1]. Recent investigation of Si whiskers doped with nickel and boron in wide range of temperatures 4.2–300 K has shown that Ni impurities could create magnetic nanoclusters [2]. So, because of the possible influence of microstructural features on the charge carrier transport these materials require more detailed consideration and research using both DC and AC measurements.

In this paper the method of impedance spectroscopy is considered for Si whiskers with B and Ni dopant concentration near the metal-insulator transition (MIT) in temperature range 4.2–70 K and at frequencies 0.01-250 kHz. It is shown that the application of the method of impedance spectroscopy gives an additional information about the nature of conductivity in doped Si whiskers near MIT and possible recharge processes in the system of impurity centers.

Data analysis of temperature dependence of conductivity shows that at high temperatures the conductivity is determined mainly by carrier thermoactivation. At lower temperatures (4.2–20 K) the conductivity occurs due to hopping transport of charge carriers on localized states. The influence of magnetic impurities on low temperature conductivity mechanism in silicon whiskers is considered. The result of the above process is presented in the Nyquist diagram in the form of an inductive or a capacitive nature of the impedance. Thus, semiconductor reactive elements based on silicon whiskers allow provision of necessary type of reactive resistance for electrical circuits.

1. *Druzhinin A. A., Lavitska E., Maryamova I. , Oszwaldowski M.* Studies of Piezoresistance and Piezomagnetoresistance in Si Whiskers at Cryogenic Temperatures// Crystal Research and Technology.- 2002.- **37**.- P.243-257.
2. *S.Yatsukhnenko, A.Druzhinin, I.Ostrovskii, Y.Khoverko, M.Chernetskiy* Nanoscale conductive channels in silicon whiskers with nickel impurity // Nanoscale Research Letters.– 2017.– **12**:78.