Nanocomposites and nanomaterials

Nanoscale Polysilicon in Sensors of Physical Values at Cryogenic Temperatures

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Most semiconductor devices, including sensors of physical quantities, were based on the temperature dependence of the electrical conductivity of crystals and their change under the influence of external factors such as frequency, current, strain, etc. [1]. Based on experimental and theoretical studies of the temperature dependence of conductance and magnetoresistance it was found that in doped nanoscale polysilicon (crystallite size is about 30 nm) the change in conductivity with temperature may be described by the Mott law, according to which the value of the magnetic field in which magnetoresistance changes sign from negative to positive is proportional to temperature as $\sim T^{3/8}$, indicating the abrupt conductivity in these samples at low temperatures. Based on analysis of the nature of the electrical conductivity of polycrystalline silicon in SOI-structures it was showed that conductivity of grained samples at cryogenic temperatures was explained by the jumps on twice occupied states of localized impurity levels, that forms a basis for the creation of supersensitive sensors of cryogenic temperatures.
There were generating a geometric model of the sensor, which deals with modeling of mechanical and thermomechanical properties of sensors structures by method of finite element (ANSYS). A selection of topological variant of the sensitive element of the sensor is reduced to two interrelated factors:
- a choice of crystallographic direction of the long axis resistor that can provide the maximum increase of its resistance;
- a choice of crystallographic plane, which contains desired crystallographic directions.

[1] A. Druzhinin, I. Ostrovskii, Y. Khoverko, R. Koretskii. Strain-induced effects in p-type Si whiskers at low temperatures//Materials Science in Semiconductor Processing.– 2015.–Vol. 40.– P. 766–771