LOW-TEMPERATURE HALL EFFECT IN SI/SIO$_2$/Ni NANOSTRUCTURES

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Tasks of the modern technology are concerned not only with the use and improvement of conventional methods of micron- and submicron-scale structures fabrication, but with a development of new principles and technological processes of the creation of nanoelectronic devices. In this concern an interest to nanoporous structures, such as silicon dioxide on silicon with metal clusters is obvious [1].

The structure Si/SiO$_2$/Ni was formed with the use of the swift heavy ion (SHI) track technology. By means of this technology a matrix with statistically uniform distribution of latent SHI tracks in a silicon dioxide surface layer on n-Si surface has been created. After etching ion tracks were transformed in pores having form of frustums with an average diameter ~150 nm and height corresponding to SiO$_2$ layer thickness (~200 nm). In this matrix Ni was electrochemically deposited as nanoclusters with a size 30 nm [2].

The studies of galvanomagnetic properties of created nanostructures were carried out on the „Cryogenic Limited“ experimental setup in temperature range 4–300 K and in transverse magnetic fields up to 12 T. Measurements error in the overall ranges of temperatures and magnetic fields did not exceed 5 %.

Investigations of temperature dependences of Hall voltage have shown that they have similar character in the overall range of magnetic field values (Fig.1). Exponential growth of the positive Hall voltage in the interval 300–100 K (insert in the Fig.1) is changed by a sharp leap by a several orders of magnitude with a change of sign in the range 100–75 K. At the T value 75–25 K one can observe a low rise of U_x. It is not possible to determine further behavior of U_x down to helium temperatures because Si turns dielectric. Magnetic field dependences of Hall voltage (Fig.2) evidence non-monotonic oscillating behavior of U_x magnitude in the overall range of temperature. These results bear witness of the presence of several charge transfer mechanisms in a broad temperature range. This has been found earlier as a result of the studies of magnetoresistance of these structures [3].

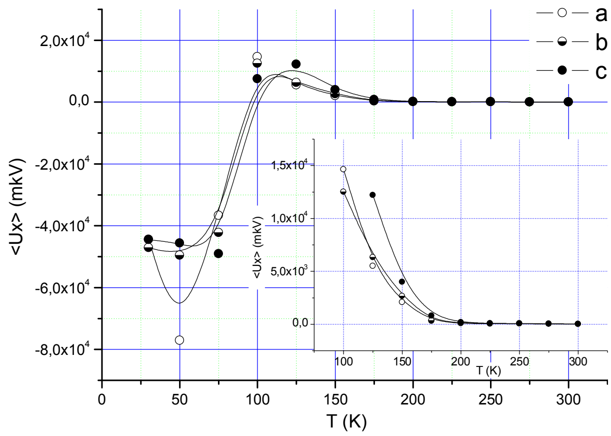

Fig. 1. Temperature dependence of Hall voltage in magnetic fields: 2 T (a); 6 T (b); 12 T (c).

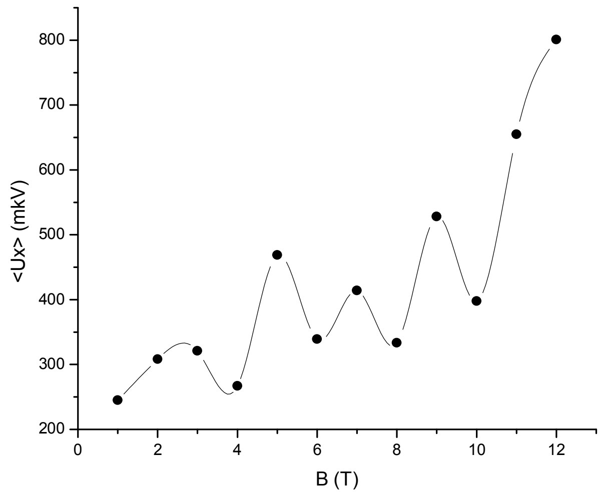

Fig. 2. Magnetic field dependence of Hall voltage at 175 K .

[1] Ion irradiation of polymers: fundamentals and applications. In: Springer Series in Materials Research, 65, Ed. by D.Fink, Springer Berlin/Heidelberg (2004)
[2] Ivanova Yu.A., et al., Journal of Materials Science, 2007, V.42, No.22, p.9163–9169.
[3] Kaniukov E.Yu., Demyanov S.E., Materialovedenie (in press).