Fractional quantum conductance in silicon nanosandwiches

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We present the findings for the fractional quantum conductance of holes that is caused by the edge channels in the silicon nanosandwiches prepared within frameworks of the Hall geometry. These nanosandwiches represent the ultra-narrow *p*-type silicon quantum well (Si-QW), 2 nm, confined by the δ-barriers heavily doped with boron on the *n*-type Si (100) surface [1]. The edge channels in the Si-QW plane are revealed by measuring the longitudinal quantum conductance staircase, G_{xx}, as a function of the voltage applied to the Hall contacts, U_{xy}. It should be noted that the important condition to register quantum conductance staircase is to stabilize the drain-source current in the range of $0.1 \div 10$ nA.

In addition to the standard plateaus, $2(e^2/h)\cdot N$, the quantum conductance staircase appears to reveal the additional plateaus at the values of $7/4\cdot(e^2/h)$, $3\cdot(e^2/h)$, and $15/4\cdot(e^2/h)$; where N denotes the number of the filled one-dimensional hole subbands. This fractional quantum conductance seems to result from the ferromagnetic exchange interaction between localized and propagating holes that gives rise to the high degree the spin polarization [2]. These findings became possible owing to the small effective mass, $<6\cdot10^{-4}\ m_0$, of the heavily holes that was controlled by studying the temperature dependences of the de Haas – van Alphen oscillations in low sheet density Si-QW [3]. Besides, the effective mass values appear to be in a good agreement with both the cyclotron resonance data and the estimations from the period of the Aharonov-Casher oscillations [1].

The G_{xx} fractional values revealed by tuning the U_{xy} voltage appear to evidence that the only closely adjacent helical channels to the sample's edge make dominating contribution in the quantum conductance as distinguished from the internal channels. The variations of the U_{xy} voltage seem to effect on the degree of the spin polarization in the edge channels. Besides, the edge channels are able to exhibit either ballistic and superconducting properties or their combination [4]. Here, the dipole centers of boron in the δ-barriers confining the Si-QW appear to result in the formation of helical edge channels along the [011] axis.

Finally, the quantum conductance staircase of holes shows the maximum value of the conductance in the edge ballistic channels, $G_{max}=4(e^2/h)$, that appears to be caused by the multiple Andreev reflections in the case of their superconducting properties.

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