Quantum point contacts fabricated from $Cd_{1-x}Mn_xTe$ heterostructures using the split-gate technique

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We present our current work on high electron mobility $Cd_{1-x}Mn_xTe$ quantum well (QW) structures. Those structures show very interesting properties such as large and tunable electron g-factor [1] and presence of the Fractional Quantum Hall Effect states [2]. Previously the quantum point contact (QPC) devices were produced from CdTe QWs by wet chemical etching where the side gates, made of the same material, were separated from the constriction area by narrow etched grooves. However, clear one dimensional conductance quantization was not observed [3]. The aim of this work was preparation of split-gate QPC devices with the use of electron beam lithography followed by deposition of metal on the surface and lift-off. The devices are to be used for the observation of both conductance quantization and exchange enhanced spin splitting of one dimensional states.

We developed the multilevel electron beam lithography process to produce the electrostatically defined conducting channel. Patterned top gates create the electric potential which restrict movement of two dimensional electron gas to a narrow channel. Advantage of using split-gate is the smoothness of confining potential, that allows to produce less disordered 1D channel and without charged surface states, normally present on the etched mesa walls. We prepared series of samples with various distances between split-gates to study the confining effect. The final device was the quantum point contact made of $Cd_{1-x}Mn_xTe$ QW.

At the low temperatures (down to 0.8K) electron transport measurements show the confinement of current and closing of the conducting channel for high negative potential applied to the gates. We show results for both nonmagnetic and magnetic QW devices having various distances between split-gate and obtained for different magnetic field values. Moreover, we observe conductance plateaus for quantized values. Experimental results are supported with numerical simulations. Current distribution and density is calculated within the tight-binding approximation with the use of Kwant code [4].

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