Local and non-local resistance fluctuations in HgTe/(Hg,Cd)Te micro-Hall bars and nanoconstrictions

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We present new resistance and magnetoresistance data for gated Hall microbridges of HgTe/HgCdTe quantum wells (QWs) with edge channel lengths from about 10 to 100 micrometers [1]. Furthermore, we show the results obtained for submicrometer constrictions created by gates in the same system. All samples are patterned from In-modulation doped single HgCdTe/HgTe/HgCdTe QW of the width d=8 nm, grown by MBE [2]. Measurements of nonlocal resistances prove that in the depletion regime the current is carried by the edge states only, as expected for a 2D topological insulator. However, high and nonquantized values of channel resistances have been shown even for channels as short as 10 micrometers. This shows that the topological protection length in our structures is even shorter, in accordance with recent results [3]. For the constrictions, we have observed pronounced quasiperiodic reproducible conductance fluctuations as a function of the gate voltage. Their amplitude strongly decreases with the temperature. Surprisingly, the resistance measured as a function of the magnetic field does not show such fluctuations. We explain these findings in terms of the charge puddles in the well, to which the electrons from the edge channels are tunnel-coupled. The puddles are formed due to the potential fluctuations in QW arising due the fluctuations of its width as well as due to random distribution of charged impurities. The transport along the edges is thus affected by the Coulomb blockade effect which is expected to weakly depend on the magnetic field.

The research was partially supported by Regional Development Program (Poland) grant WND-RPPK 01.03.00-18-053/12 and European Program POIG.01.01.02-00-008/08.

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