Non-linear quantum transport in $n-$type CdMgTe/Cd(Mn)Te *quasi*-ballistic microstructure

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Modulation doped CdMgTe/Cd(Mn)Te structures combine the high mobility of two dimensional electron gas (2DEG) with the extremely large and tunable Landè g-factor, which makes such a quantum wells the material of choice for the construction of semiconductor spintronic nanodevices. Recently, the effective change of the spin splitting has been realized by the application of a strong external electric field oriented along the growth direction of magnetic quantum well [1]. However, the fabrication of top- and bottom electrostatic gates, which are used for that purpose, may be technologically challenging.

In this paper we show, that the g-factor of a magnetic two-dimensional electron gas can also be *tuned electrically* by an increase of the source-drain voltage, when a device operates in the non-linear transport regime. This finding may greatly simplify the design of a future spintronic structures, since less processing steps will be needed for the final assembly. The only requirement is that the sizes of a conductive channels are reduced below the inelastic coherence length of a 2DEG.

We present the results of low-temperature magneto-transport measurements performed on *quasi*-ballistic microstructure defined lithographically on the $n-$type $Cd_{98.5}Mn_{1.5}Te$ QW having barriers made of CdMgTe. The density of two-dimensional electron gas and its mobility at temperature $T = 4.2$ K were determined to be 3.0×10^{11} cm^{-2} and 2.0×10^{5} cm^{2}/Vs, respectively. The sample was formed as a $\Pi-$shaped multi-terminal device with an overall size of 5 μm. We studied the local and non-local differential magnetoconductance in the linear and non-linear transport regimes. Data were collected as a function of source-drain $V_{\rm sd}$ voltage and magnetic field B up to 6 T. Measurements were carried out in the cryo-free dilution refrigerator Triton 400 at the base temperatures ranging from 0.01 to 0.3 K.

At low magnetic fields ($B < 1$ T) we have observed the Shubnikov-de Haas (SdH) oscillation with the characteristic beating pattern which is a consequence of the giant Zeeman splitting [2]. We show that nodes of such pattern, where the oscillations have a vanishing amplitude, are considerably shifted when $V_{\rm sd}$ is increased up to 4.5 mV. Therefore we conclude, that induced changes of g-factor result from a non-equilibrium population of the spin-splitted Landau levels. Furthermore, at stronger fields ($B > 3$ T) we have observed the very high and narrow magnetoconductance peak related to the transition to quantum Hall ferromagnet (QHFM) state [3]. In the language of edge currents, a QHFM phase corresponds to the unique situation when two channels, carrying electrons with opposite spins, cross in real space. We show that this process can also be controlled by a source-drain voltage.

The research was partially supported by National Science Centre (Poland) under the grant DEC-2012/06/A/ST3/00247, the EU 7th Framework Programme Grant No. REGPOT-CT-2013-316014 and Regional Development Program (Poland), grant WND-RPPK. 01.03.00-18-053/12.

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