Research & Reviews in Polymer

Vol 10, Iss1

Topological Insulator based on semi-metallic alloy HgCdTe

G. Tomaka, J. Grendysa, P. Śliż, D. Żak and E.M. Sheregii *

Uniwersytet Rzeszowski, Centrum Mikroelektroniki i Nanotechnologii

Author email: sheregii@ur.edu.pl

ABSTRACT

HgCdTe (MCT) alloy is a standard material with strong spin-orbital interplay which lifts the G_8 band above the G_6 one. This is why a Dirac point (the Γ6 and Γ8 crossing causes a singularity in electron shape with linear dispersion and zero effective mass of fermions) is realized when the composition of MCT is various from HgTe to CdTe what makes the 3D topological Dirac semimetal HgCdTe as a natural analogue of graphene in 3D.

This thesis is confirmed by way of the experimental consequences of the magneto-transport measurements over a extensive c program languageperiod of temperatures for nineteen layers of MCT (x ≈ zero.13 - zero.15) grown by means of MBE provided in our paper. That are samples of three series: series A - strained thin (about 100 nm thickness) layers on the GaAs/CdTe substrate; series AB – no strained thin layers on the ZnCdTe substrate and series B – thick (about 1000 nm thickness) layers on the ZnCdTe substrate. The results obtained for sample A9, namely, the $R_{xx}(B)$ and $R_{xy}(B)$ curves (see Fig. 1), show for different temperatures over wide range from 0.4 K to 50 K the well-defined quantized plateaus in R_{xy} with values $h/(2e^2)$ = 12.9 kΩ, accompanied by vanishing R_{xx} is observed at 0.4 K what explicitly indicate on the Integer Quantum Hall Effect (IQHE) and Shubnikov-de Haas (SdH) oscillations characteristic for 2D electron gas. The $R_{xx}(B)$ and $R_{xy}(B)$ curves are reproducible up to 20 K and above this temperature the Integer Quantum Hall Conductivity (IQHC) is observed up to 50 K. That can be defined by means of conductivity on topologically protected surface states (TPSS). An exquisite temperature stability of the SdH-oscillation period and amplitude is discovered inside the whole temperature c program language period of measurements as much as 50 okay for samples of series AB (Fig.2) and B also (see Fig.2).). In the case of no strained layers (series AB and B) it is assumed that the TPSS contributes (and dominates) also to the conductance of the bulk samples.

Interpretation of received experimental effects could be based totally on the kp-theory of band structure along with axial stresses (for samples of series A). The fan of Landau levels can be calculate using the Dirac equation with electron pace at the Fermi level vF= 106 m/s that is plenty larger than for other 3D Tis. As Topological Insulator (IT) HgCdTe have important advantages: high cost of the Fermi pace – about similar to for graphene, which leads to an increase in the attractiveness of TI for future applications: as massless Weyl fermions.

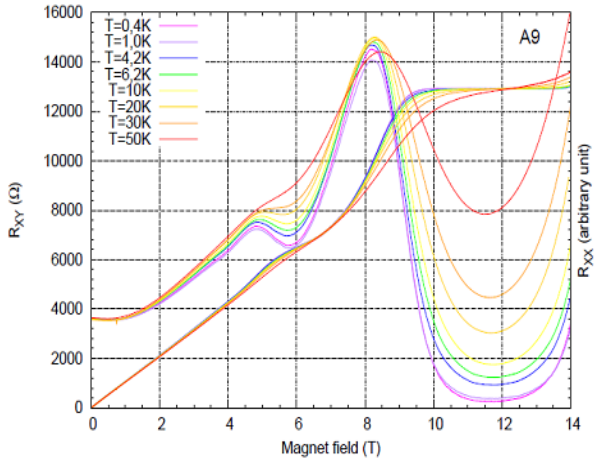

Fig. 1. The Rxx(B) and Rxy(B) curves for sample A9

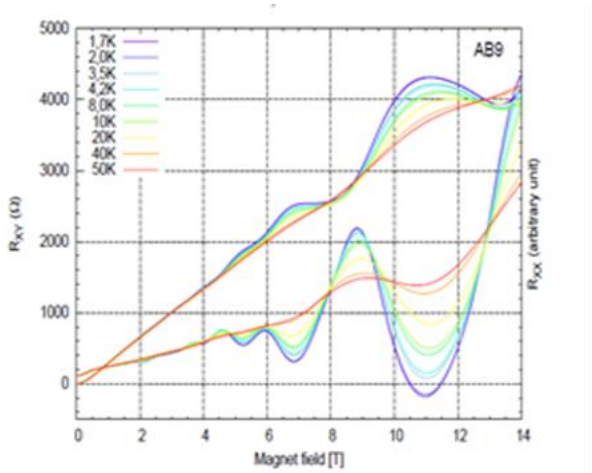

Fig. 2.The Rxx(B) and Rxy(B) curves for sample AB9.