Nanoscale physics

HgCdTE alloys as Natural 3D analog of Graphene

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HgCdTe (MCT) alloy is a typical material with strong spin-orbital interaction which lifts the Γ8 band above the Γ6 one. That is why a Dirac point (the Γ6 and Γ8 crossing that causes massless fermions) is realized when the composition of MCT is varied from HgTe to CdTe what makes the 3D topological Dirac semimetal HgCdTe as a natural analogue of graphene in 3D.

In this report experimental results of the magneto-transport measurements over a wide interval of temperatures for nineteen layers of MCT ($x \approx 0.13 - 0.15$) grown by MBE are presented [1]. 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 $R_{xx}(B)$ and $R_{xy}(B)$ curves are shown for different temperatures over wide range from 0.4 K to 50 K. The well-defined quantized plateaus in R_{xy} with values h/(2e2) = 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 explained by conductivity on topologically protected surface states (TPSS). An amazing temperature stability of the SdH-oscillation period and amplitude is observed in the entire temperature interval of measurements up to 50 K for samples of series AB and B also. Moreover, the IQHE behavior of the Hall resistance is registered in the same temperature interval. In the case of no strained layers (series AB and B) it is assumed that the QHC on the TPSS contributes (and dominates) also to the conductance of the bulk samples.

As Topological Insulator (IT) HgCdTe have important advantages: high value of the Fermi velocity – approximately the same as for graphene, what leads to an increase in the attractiveness of this TI for future applications: as massless Weyl fermions [2].

1. G. Tomaka et al., *Phys. Rev. B*, **93**, 205419 (2016)

2. M. Marchewka, et al., *Solid State Communication,* **250,** 104-107 (2016)