Transport properties of a 3D topological insulator on the basis of a strained high mobility HgTe film

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The discovery of 2D and 3D topological insulators (TI) has opened a new and exciting research field in condensed matter physics [1,2]. Recently a single Dirac cone has been observed by the angle resolved photoemission spectroscopy in the strained HgTe films [3]. However, there has been no clear evidence of the presence of 2D Dirac fermions in the transport properties in the mentioned above HgTe film. In our work we report the investigation of transport properties of a high mobility ($\mu = 4 \times 10^5$ cm^2/V·s) 80 nm wide HgTe film furnished with a top gate. In our research we observed a controlled by the gate voltage transitions between three states: a 3D electron metal, 2D Dirac surface states and a 3D hole metal in the film. We performed transport measurements in a temperature range from 1.9 K to 15 K and in a magnetic fields up to 10 T and revealed several features and the whole of them are agreed with proposed model of three states. The gap in the energy spectrum of the film is found to be (15 meV), consistent with the recent calculations [3]. These main features observed are following:

1. Typical resistivity versus gate voltage dependencies $\rho_{xx}(V_g)$ at $T = 1.9$ K in zero magnetic field is a smooth curve with a single maximum which corresponds Fermi energy near the top of the valence band. The gate voltage range corresponding TI state are bounded by valence band (E_v with arrow on a fig.) and conductive band (E_c on a fig.).

2. At the gate voltages corresponding to the Fermi level lying in the gap a quantum Hall effect is observed due to the 2D Dirac electrons from the two surfaces of the film.

3. When the Fermi level is outside the gap a scattering is detected between the 2D Dirac electrons and the bulk electrons/holes. Scattering with holes resulting in T^2-proportional positive temperature coefficient of resistance for $V_g < 2$ V.

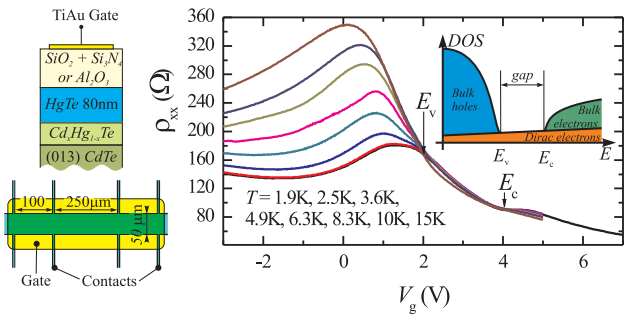

Figure 1: The sample schematic and $\rho_{xx}(V_g)$ dependence at zero magnetic field.

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