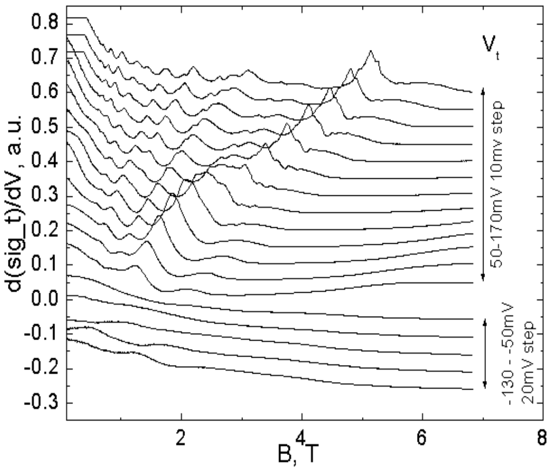
Electron tunneling spectroscopy of 2D HgTe quantum well with inverted energy spectrum

Andrey A. Sherstobitov[1,2], Grigori M. Minkov[1,2], Aleksander V. Germanenko[2], Olga E. Rut[2], Nikolay N. Mikhailov[3], Sergei A. Dvoretski[3]

[1] *Institute of Metal Physics, UbRAS, Ekaterinburg, Russia.*
[2] *Ural Federal University, Ekaterinburg, Russia.*
[3] *Institute of Semiconductor physics, RAS, Novosibirsk, Russia.*

The progress in semiconductor technology allows us to get the high quality 2D heterostructures on gapless semiconductor HgTe. By the variation of the composition and width of the quantum well in this material we can tune the gap width and the energy spectrum. In particular at the well width of 6.3 nm this is the gapless semiconductor with Dirak like energy spectrum. Due to this fact these structures are attractive for experimentalists and theorists.

The electron tunneling spectroscopy is the tool to study the energy spectrum of semiconductor structures. In this method the differential conductivity of the contact between the metal and semiconductor separated by thin insulator is measured. In the simplest case the Fermi energy of semiconductor is independent on the applied voltage between the metal and semiconductor V_t. Then the applied voltage is equal to the difference between Fermi energies of metal and semiconductor. The differential conductivity of the contact is proportional to the density of states in the semiconductor at the Fermi energy of metal. So by the study of the differential conductivity versus V_t it is possible to obtain the energy spectrum of the semiconductor. In this work we present the study of the energy spectrum of 2D HgCdTe/HgTe/HgCdTe quantum well structure by this method.



The samples was grown on [013] GaAs substrate. The width of quantum well HgTe was 20nm. Before preparation of the contacts (Al) the cap layer was partially etched by Br/Butanol based etchant. So we tune the conductivity of the barrier, in order to reach the measurable, but still tunneling, conductivity. It was found that the optimum conductivity is about few mkS. The measurement was carried out at the temperature (1.5-4.2) K in the magnetic fields up to 7 T.

The oscillations of the differential conductivity on V_t and the magnetic field were found in the investigated structures. Typical dependence of the differential conductivity on the magnetic field at different V_t is displayed on the figure. The analysis of these dependencies shows that, unlike the simplest case, in our case the Fermi level depends on V_t. The detailed analysis of the dependences allows us to shed light on the peculiarities of the spectrum of the two dimensional carriers and its dependence on the magnetic field in such interesting system.

This work has been supported in part by the RFBR (Grant Nos. 11-02-12126, and 12-02-00098).