Transport experiments in InAs/GaSb broken-gap quantum wells

Fabrizio Nichele, Atindra Nath Pal, Patrick Pietsch, Christophe Charpentier, Werner Wegscheider, Thomas Ihn, and Klaus Ensslin

ETH Zurich, Solid State Physics Laboratory, Schafmattstrasse 16, Zurich, Switzerland

An InAs/GaSb double quantum well sandwiched between two AlSb barriers shows a peculiar type-II band alignment. A quantum well for electrons in InAs and a quantum well for holes in GaSb coexist next to each other. If the quantum wells' thicknesses are small enough a small hybridization gap can open for finite k-vectors. Depending on the quantum wells thicknesses and on the perpendicular electric field applied to the structure, a rich phase diagram is predicted. It should be possible to electrically tune the sample from standard conducting phases to insulating, semimetallic or topological insulator phases [1,2]. Recent work on InAs/GaSb quantum wells showed the presence of a residual conductivity in micron-sized Hall bars and interpreted with the existence of helical modes [4,5], as expected for the quantum spin Hall insulator phase [6].

We present transport measurements performed on ambipolar InAs/GaSb double quantum wells at cryogenic temperatures. The large dimension of the devices in use does not allow us to resolve the presence of helical modes at zero magnetic field. We focus our attention on magnetotransport phenomena that allow us to better understand the peculiarity of the band structure under study. Similarly to what was observed in graphene [7] and in semimetallic HgTe quantum wells [8,9], the resistivity at the charge neutrality point strongly increases in a high perpendicular magnetic field. The resistivity increase is accompanied by a giant non-local response that has been interpreted as resulting from counter-propagating electron and hole edge channels. Here we show that the above cited effects are visible in InAs/GaSb as well and we study them as a function of top gate voltage, magnetic field and temperature. Particular attention is given to the nature of the giant non-local response and to its dependence on temperature and distance between Ohmic contacts.

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