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Magnetotransport in the topological insulator candidate InAs/GaSb[1]

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InAs/GaSb quantum wells have been proposed as an electrically tunable two-dimensional topological insulator system. Transport can be tuned from the electron to the hole regime whereby the Fermi-energy crosses the hybridization gap, where topological edge states are predicted to exist. We have investigated this material system using dc magneto-transport measurements at cryogenic temperatures. In high-mobility large-area samples, a resistivity maximum is observed at the charge-neutrality point. It increases strongly with magnetic field. At the same time, a strong non-local resistance appears which we describe by a model of helical and dissipative quantum Hall edge channels shorted by residual bulk conductivity. In an attempt to reduce the bulk conductivity, we have grown samples with slightly impure Gallium. Large-area devices show a peak resistance at the charge neutrality point enhanced by almost three orders of magnitude compared to the high-mobility samples. A requirement for observing the topological insulator state is the fabrication of devices smaller than the inelastic scattering length. We have developed an optimized fabrication recipe by comparing samples produced with wet and dry etching. The former turns out to be favorable for obtaining smooth edge potentials and a width-independent electron density. With this fabrication technology we have produced small-area Hall bar devices with widths and contact separations in the micrometer range. Surprisingly these devices do not exhibit a resistance maximum at charge neutrality like large-area devices, but rather show a plateau-like local resistivity at negative gate voltages. At the same time the Hall density saturates in these devices at finite electronic densities instead of turning into the hole regime, and a systematic non-local resistance signal appears in all devices. We discuss these findings in view of conflicting interpretations involving either fabrication issues or the proposed helical edge modes.

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