Magnetotransport in nanostructured InAs-based High Electron Mobility Transistors

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The controlled creation, manipulation and detection of spin-polarized currents by electrical means is of high interest. Here we investigate narrow-gap semiconductors with large spin-orbit coupling. Nanostructures can be used to filter specific momentum modes and possibly to create and detect spin-polarized currents [1, 2].

We use wafers with a InAs/InGaAs/InAlAs double quantum well structure [3], containing a shallow two-dimensional electron gas at about 45 nm depth (Fig. 1a). At 4.2 K the carrier density is $n \approx 3 \times 10^{11}$ cm^{-2} and the mobility $\mu \approx 1 - 9 \times 10^4$ Vs/cm^2 in the dark. We fabricate Hall-bars and quantum point contacts (QPCs) with in-plane gates (Fig. 1b), using micro-laser and electron-beam lithography and wet chemical etching, in order to investigate spin-polarized currents when asymmetric gate-voltages are applied.

The in-plane gates are successfully employed to vary the QPC width and the QPCs show conductance quantization from 300 mK up to 1.8 K (Fig. 1c). Applying asymmetric gate-voltages shifts the onset of the conductance curves and DC-bias measurements indicate a shift in the subband structure. Here, we present the results of our magnetotransport measurements and discuss their implications for investigations of the spin-orbit coupling in InAs.

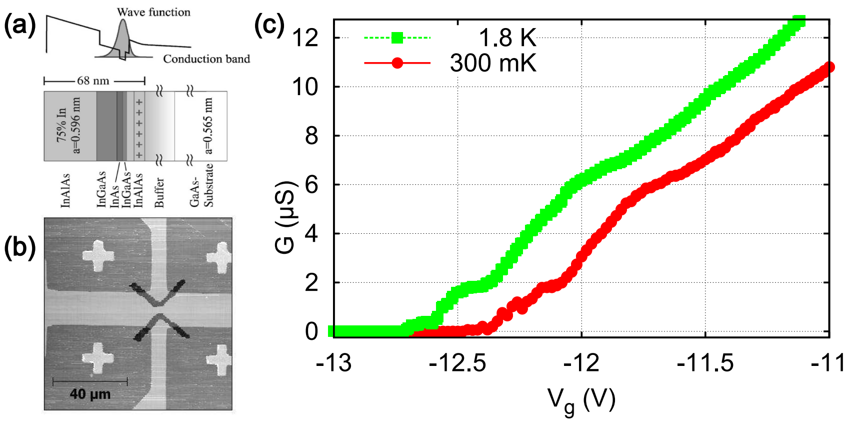

Figure 1: *a*) Scheme of the layer sequence, conduction band and electronic wavefunction of the wafer (from [3]). *b*) Atomic force microscopy image of a QPC. The width and length of the constriction are approximately 1.5 μm and 6 μm, respectively. *c*) Conductance G as a function of gate voltage V_g of a QPC similar to b, at two different temperatures.

[1] R. H. Silbsee, *J. Phys.: Condens. Matter* **16**, R179 (2004).
[2] P. Debray *et al.*, *Nature Nanotech.* **4**, 759 (2009).
[3] C. Heyn *et al.*, *J. Crystal Growth* **251**, 832 (2003).