
Mesoscopic Electronic Device Fabrication

Personnel

M. Abraham, M. Mondol, R. J. Ram, and H. I. Smith

Sponsorship

NSF

Mesoscopic quantum-effect electronic devices in semiconductor heterostructures have been studied extensively over the past few decades. Most of the experiments have focused on the quantum nature of the electronic wavefunction and have been studied in systems where electron transport is ballistic.

Conventional electronic devices in which electron transport is diffusive (or ohmic) have been understood for a long time. Indirect experimental evidence and theoretical calculations imply that the transition between the ballistic and diffusive regimes, in the case of a high-mobility two-dimensional electron gas (2DEG), involves an intermediate regime that displays “hydrodynamic” like behavior.

The hydrodynamic regime for electron transport should occur in a 2DEG when the temperature of the electron gas is high and therefore the electron-electron scattering rate is very large. Figure 18 shows gold Schottky gates made using e-beam lithography, that define a Quantum Point Contact (QPC) on a 2DEG GaAs/AlGaAs heterostructure substrate. QPCs exhibit quantized conductance and thermopower, and can be used to measure the electronic temperature of a 2DEG. Experiments are being designed incorporating QPCs into devices to study electron transport. The QPCs should enable the simultaneous measurement of electron temperature along with the conductance of a device. These devices will probe quantitatively the intermediate regime between ballistic and diffusive transport.

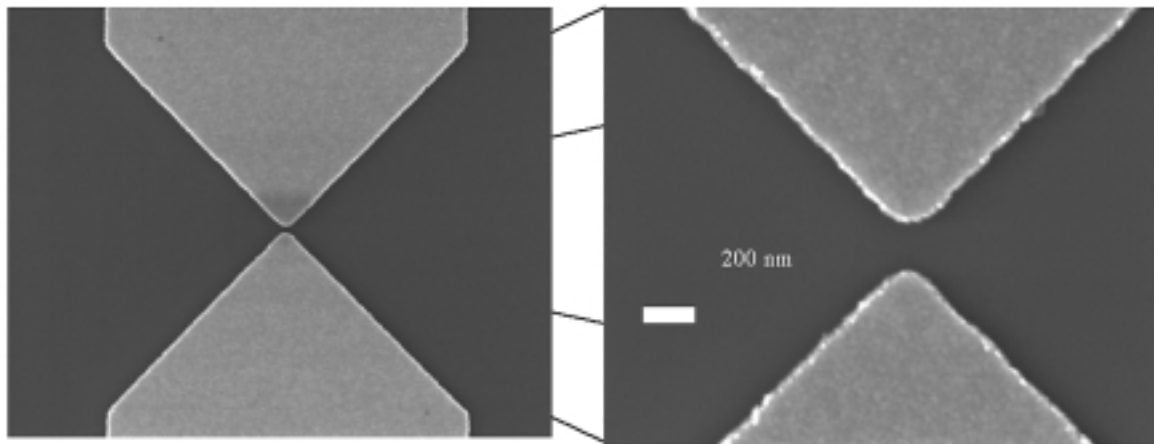


Fig. 18: : Gold Schottky gates made using e-beam lithography, define a quantum point contact (QPC) on a two dimensional electron gas (2DEG) GaAs/AlGaAs heterostructure substrate. The QPC exhibits quantized thermopower and can therefore be used to measure the electronic temperature of the 2DEG.
