Electron and hole transport in Ambipolar GaAs devices

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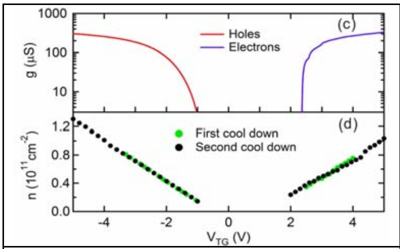
We review recent work on ambipolar undoped GaAs/AlGaAs heterostructure devices, in which the channel can be switched from a high quality 2D electron gas to a 2D hole system simply by changing the top gate bias.

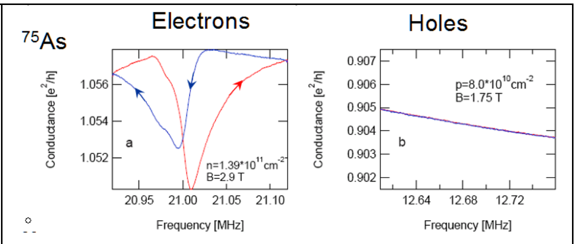
In two-dimensional systems we have performed a direct comparison of the scattering mechanisms of electrons ($\mu_{peak}=4\times10^6$ cm^2/Vs) and holes ($\mu_{peak}=0.8\times10^6$ cm^2/Vs) in the same conduction channel with nominally identical disorder potentials. We find significant discrepancies between electron and hole scattering, with the hole mobility being considerably lower than expected from simple theory [1].

In one-dimensional devices we have studied electron and hole transport in the same quantum point contact. We observe quantized conductance steps, and use source drain biasing to extract the subband spacing for both electrons and holes in the same point contact. [2]

Finally we have used these devices to study the hyperfine coupling of holes with the Ga and As nuclei in the host crystal for the first time [3]. Resistively detected NMR measurements in the quantum Hall regime show that the magnitude of the resistance change and associated NMR peaks in n-type devices is in line with previous measurements, whereas no signal could be detected for p-type devices. This suggests that the hyperfine coupling between holes and nuclei in this type of measurement is much smaller than the electron hyperfine coupling, which could have implications for quantum information processing.



Ambipolar operation of an undoped 2D heterostructure [1].



Resistively detected NMR for electrons and holes [3].

[1] J. C. H. Chen *et al*, Appl. Phys. Lett. **100**, 052101 (2012).
[2] J. C. H. Chen *et al*, (unpublished).
[3] Z. K. Keane *et al*, Nano Letters **11**, 3147 (2011).