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Declaration

Except where specifically stated, all the work described in this Thesis was carried out by the author or under his direction. The devices in Chapter 5 were created by Dr. M. A. Sadegzahdeh at the University of Warwick (55/53) and Dr. H. E. Fischer at Siemens, now Infineon. The device in Chapter 6 was created by R. Ferguson at Imperial College. The devices in Chapter 7 were created by Dr. C. J. E. Emeleus at the University of Warwick.

The computer code used to calculate mobility was written by Dr. A. I. Horrell, and the computer code used to perform Bryan's Algorithm Mobility Spectrum is based on code written by Dr. J. P. Hague.

Abstract

The work presented here describes the electrical characterization of n- and p-type strained silicon-germanium systems.

Theories of quantum transport in low magnetic fields at low temperature are discussed in terms of weak-localization: the traditional theory is shown not to account for the dephasing in a 2-dimensional hole gas behaving in a metallic manner and emergent alternative theories, while promising, require refinement. The mobility as a function of sheet density is measured in a p-type pseudomorphic $Si_{0.5}Ge_{0.5}$ across the temperature range 350mK-282K; it is shown that calculations of the mobility based on semi-classical scattering mechanisms fail below 10K where quantum transport effects become relevant. A room temperature Hall scattering factor has been extracted.

A new functional form has been presented to fit the resistivity as a function of temperature, below 20K: traditional theories of screening and weak localization appear not to be applicable.

It is also demonstrated that simple protection circuitry is essential if commercial-scale devices are to be meaningfully investigated.

Mobility spectrum analysis is performed on an n-type strained-silicon device. Established analysis methods are discussed and a new method is presented based on the Bryan's Algorithm approach to maximum entropy. The breakdown of the QHE is also investigated: the critical current density compares well to that predicted by an existing theory.

Finally, devices in which both electron and hole gases can be induced are investigated. However, it is shown that the two carrier species never co-exist. Design rules are presented which may allow more successful structures to be created. Results are presented which demonstrate the success and the utility of implanted contacts which selectively reach different regions of the structure.