NAME	James Sedgwick Richardson-Bullock
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THESIS TITLE	On the performance modelling and development of a two dimensional electron-gas milliKelvin cooler.

PROJECT OUTLINE

MilliKelvin coolers represent a developing technology within nano-silicon research. Research to date has confirmed the principles on which this technology is based and has suggested a number of performance limiting factors including, but not limited to, the device material, manufacturing methods and device geometry.

Experiencing the experimental aspects of cooler manufacture and performing measurements on completed prototypes is one aspect of this project. Another would be to develop a model capable of accurately and reliably simulating experimental data produced by a number of different devices, without the use of free parameters.

Such a model could not only shed light on the predicted hierarchy of the suspected performance limiting factors, but could also suggest methods by which they may be minimised or eliminated. Furthermore, adjustments to such a model could allow preliminary investigation into previously unexplored cooler configurations, such as those with two dimensional electron gasses, the suspected advantages of which suggest this to be valuable area of study.

KEY TEXTS

1. Relevant chapters of L. Solymar “Electrical properties of materials”
2. Relevant chapters of S.M. Sze “Semiconductor devices”
3. Relevant chapters of D.K. Schroder “Semiconductor material & device characterisation”
4. A. Savin et al, Physica B **329-333** (2003)
5. M. Prest et al “MilliKelvin tunnelling refrigerators”

OTHER TEXTS

1. R.F. Pierret “Semiconductor fundamentals”
2. E.H. Rhoderick “Metal-Semiconductor contacts”
3. A.C. Rose-Innes and E.H. Rhoderick “Introduction to superconductivity”
4. S. Rajauria “Electronic refrigeration using superconducting tunnel junctions”
5. P. Kivinen “Electrical and thermal transport properties of semiconductor and metal structures at low temperature”

TAUGHT COURSES

1. EX3 Crystallography
2. EX5 Semiconductors I
3. NS2 Electronic Structure
4. EX6 Semiconductors II

INITIAL TASKS

(a) OCT-DEC

1. Familiarize self with ^{3}He system and other major laboratory equipment.
2. Characterise recently produced PtSi wafers.
3. Model behaviour of 3D electron-gas strained silicon device and identify its position on $T_{min}/R_T/R_{sm}$ curve.

(b) JAN-MAR

1. Use model to determine the theoretical advantages/disadvantages of a 2D electron-gas silicon device.
   Suspected advantages include: lower R_{sm}, large increment in MFP and mobility (minimising Adnreev current) and a decrease in electron-phonon coupling.
2. Research into Andreev current driven model utilised by S. Rajauria et al.

6 MONTH MILESTONES

1. Be able to accurately fit characteristic measurements of a range of 3D electron-gas silicon devices using one model.
2. Have a real and substantial body of evidence on the expected performance of a 2D electron-gas silicon device.