

Electrical and theoretical results from self-aligned side gates to carbon nanotubes

L.A.W. Robinson¹, A.L. Sierra¹, S. Furuta², A.S. Teh³, D. Gunlycke⁴, M.H. Yang³, R.G. Lacerda³, K.B.K. Teo³, G.A.J. Amaratunga³, W.I. Milne³, D. Williams⁵, D.G. Hasko¹

¹Microelectronics Research Centre, Cavendish Laboratory, Cambridge University. ²Physics, Cavendish Laboratory, Cambridge University. ³Engineering Dept, Cambridge University
⁴Dept. Materials, Oxford University . ⁵Hitachi Cambridge Laboratory, Cambridge.

In principle, a carbon nanotube is an almost perfect nanowire, in which to study low dimensional physics. In practice, studies have been limited by the lack of effective techniques for the local control of tunnel barriers and quantum wells in the nanowire. Recently, self-aligned side gates, with a very small spacing to a carbon nanotube, have been fabricated, which can overcome some of these limitations [1]. In this paper, we show experimental results for electrical transport in a carbon nanotube with self-aligned side gates and corresponding modelling. These results show that good control over the nanowire properties is possible, when applying a transverse electric field.

The fabrication technique, used to form the self-aligned side gates, allows a gate to be placed within a few nanometres of the edge of a nanowire (Figure 1); the gate is formed using a magnetic material in this work, which can lead to a large magnitude, magnetic field, localised to a small region of the nanotube. A theoretical scheme for single-electron spin detection and initialisation, with particular relevance to quantum information processing, is presented. This scheme is based on an elongated quantum dot (nanotube) orientated in a highly non-uniform magnetic field formed from magnetic self-aligned side gates and coupled to a detector with a high charge sensitivity, for example, a single electron transistor.

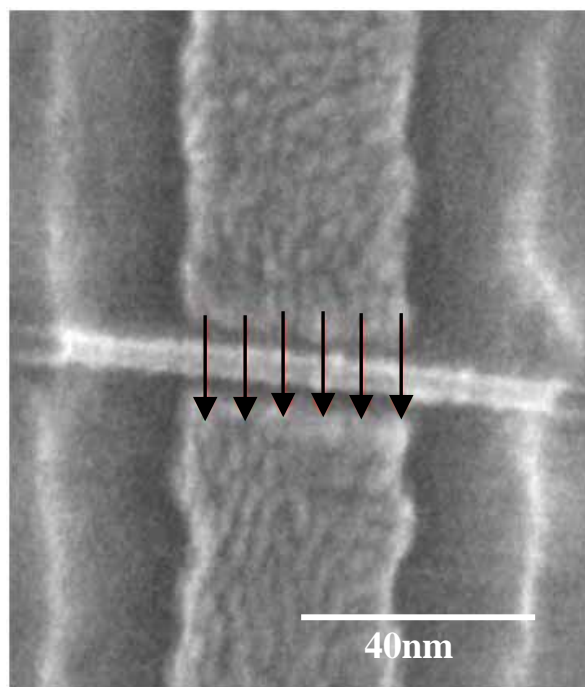


Figure 1. A predominantly single domain, self-aligned side gate made from an evaporated magnetic material will form a strong transverse magnetic field (red arrows) in the associated region of the nanotube. Such an arrangement should create local fields of the order of 0.5T.

[1] L A W Robinson *et al.* Nanotechnology 14 (2003) 290